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ABSTRACT

This science curriculum guide for grades K-6 consists of a continuum of fundamental skills and attitudes along which students progress from K-6, gradually strengthening their understanding of science. Process skills and attitudes are emphasized in this guide using content as the vehicle for learning the skills and attitudes. Six sections are presented: (1) goals and objectives, (2) skills, (3) attitudes and values, (4) elementary science curriculum models, (5) examples of K-6 science framework, and (6) appendices. The appendices include performance expectations, guidelines for selecting a program, helpful hints, student guide for projects, science laboratory safety and practices, resource materials, and a teacher suggestion form. (DS)

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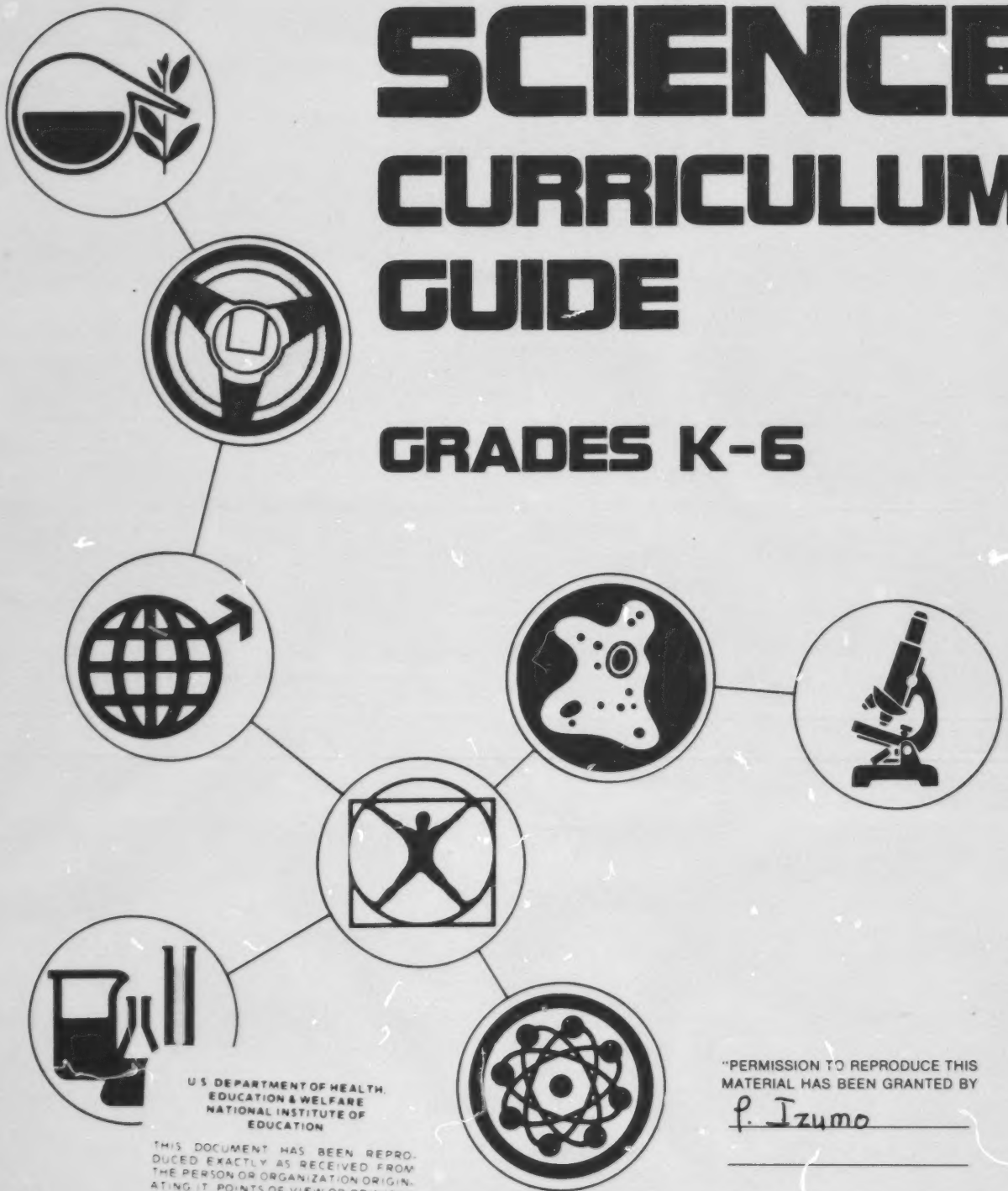
SCIENCE CURRICULUM GUIDE

GRADES K-6



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FOREWORD

Science is a dynamic, on-going human enterprise. It is a way of describing and interpreting a universe of which we are all a part. Science is an explanation of the natural phenomena of the universe--an environment with which we interact and are affected profoundly. The result is that we daily shape and are shaped by our environment.

The human enterprise of organized research and development known as modern science has produced an enormous increase in the growth of knowledge and pace of technological change. As a result, society is becoming more scientific-based, technological, and complex. Therefore, the need for literacy in science and technology is growing in importance and necessity if individuals are to keep themselves informed about critical social and environmental issues, cope with change, and make effective decisions in their futures-planning.

To meet the need for developing a "scientifically literate" population, schools will have to provide programs which promote the acquisition of a basic knowledge of science. These programs will have to be designed for students--most of whom will never be scientists--who need to understand and appreciate the impact of science and technology on their past, present, and future environments.

This curriculum guide focuses on providing the kind of scientific experiences and education which enable individuals to become independent and contributing members of a rapidly changing society. It also includes some suggestions about explicitly training students in how to think in order to enable them to more fully participate in the interactions among science, technology and society.

Charles G. Clark
Superintendent

JAN 2 6 1981

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The Science Curriculum Guide, Grades K-6 is the result of the cooperative efforts and the thinking of many people. It reflects most of their beliefs, experiences, and points of view on which direction elementary science education should take.

The following individuals have helped by either assisting in the identification of the important process skills and attitudes or by examining the draft copy of the guide.

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NOTE TO THE ADMINISTRATOR

One of the major roles of the educational administrator--principal, superintendent, department head, district educational specialist, and other resource personnel--is to serve as a leader in attaining the goals of schools. Leadership in clarifying and/or defining goals and objectives for each school will enhance the assessment, implementation, and/or modification of the total science curriculum offered by our schools.

Administrative leadership and support are essential if schools are to ensure the successful maintenance of quality science education for our students. This leadership involves providing for planning, organizing, coordinating, staffing and directing the school's curriculum on the basis of an assessment of teacher-student needs, a survey of school-community resources and the identification of the schools' goals and objectives.

To meet teacher needs, administrators can arrange for design and use of appropriate classroom and outdoor laboratory spaces and facilities, provide funds for necessary materials and equipment, and encourage utilization of available school and community resources. All successful school science programs are marked by creative and supportive school leaders.

Specific areas of concern to administrators and teachers in assessing and/or selecting science programs are discussed in the following pages under "Guidelines for Selecting a Program". The planning, development, implementation and evaluation of science program suited to the needs of students in every classroom will result in excellence in science teaching and learning.

NOTE TO THE TEACHER

Every teacher is unique in terms of experiences, training, and talent. This very uniqueness can bring the kind of spontaneity and creativity so necessary in the elementary classroom. Teachers can teach science effectively if they remember to be learners as well as teachers of science. By experiencing science along with their students, teachers can create an atmosphere of learning that is conducive to dynamic science education programs. Teachers should perform investigations with their students. By seeking answers and making explorations into the "nature of science" with their students, teachers can impart important attitudes, values, and skills which are a major part of science as a human activity.

Although a background in science is desirable, it is not absolutely necessary for effective science teaching. If science education at the elementary level is viewed as experience-based and integratable with other subject matter areas, teachers can effectively teach science by keeping in mind that skills, attitudes, and values cut across subject matter lines.

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INTRODUCTION

"Our society is evolving at an astounding rate. The society of today is marked by social unrest booming space and undersea exploration, affluence, urbanization, a knowledge explosion, increasing leisure, and changing political and ethical values. But the society of tomorrow will inevitably be different, for change is an immutable law of life. As a result of changes in our society which are already occurring, the institution of public education will need to undergo equally rapid and significant changes in order to be relevant and meaningful.

"Since education is the principal agency charged with the task of equipping the individual for a lifetime of effective living and learning it must provide a program which will allow him/her to deal effectively with the world that is already upon him/her, as well as a yet-unknown world which is certain to converge on him/her with dramatic suddenness. Thus, planning for the future becomes urgent if we are to understand future requirements and cope with them in an orderly and efficient manner."[1]

The educational purposes as stated in the Master Plan for Public Education in Hawaii indicate the ends to which our educational system should direct its efforts. The following are Department of Education's educational purposes:

1. To assure that each student acquires, to the fullest extent possible, the basic skills of speaking, reading, writing, listening, computing and thinking.

2. To encourage and foster in each student a positive attitude toward the school environment and toward the learning process.

3. To make certain that individual students acquire an understanding and appreciation of the roles of science and technology in improving our way of life.

4. To encourage the individual student to acquire the attitudes and skills of intelligent leadership, cooperation, and service.

5. To ensure that individual students understand and appreciate other individuals belonging to social, cultural, and ethnic groups different from his/her own.

6. To make certain that each individual student acquires sound habits of mental and physical health.

7. To foster and encourage in the individual student an understanding and appreciation of the fine arts and to express himself/herself creatively through them.

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[1] Master Plan for Public Education in Hawaii. Department of Education, September, 1969.

8. To develop an individual understanding of family responsibility.

9. To assure that the individual student acquires the understanding of ethical and moral questions that will enable him/her to consider and acopt a set of values which will guide his/her behavior.

10. To make certain that individual students acquire insights and skills which lead to vocational productivity.

11. To assure that each student acquires an understanding of the forces that bring high productivity and a rising standard of living in the nation and the world.

The educational purposes of the Department of Education seek to provide students with equal opportunities for a basic education, and prepare them for the lifelong process of self-education.

"The Foundation Program is a plan to fulfill the commitment for equal opportunities in education as stated in the Master Plan for Public Education in Hawaii. It offers students the school programs through which they can acquire the fundamental skills of computation, language, the arts, the physical and social sciences. The Foundation Program also provides students with the opportunities to use and practice these skills to communicate and acquire knowledge; to pursue knowledge independently and apply that knowledge in making decisions; to grow in personal/social development; to develop and maintain good health; and to be able to choose from a variety of career opportunities.

"There are eight Foundation Program objectives. These statements of objectives indicate the kinds of behavior we hope to see students demonstrate as they grow into adulthood. The list of objectives covers those related behaviors that describe students as active, contributing human beings in our society."[2]

The eight Foundation Program objectives are:

1. Basic learning and communication skills at his/her proficiency level (tool skills).

2. Positive self-concept, therefore, the ability to relate to others.

3. Decision-making skills at his/her proficiency level (process skills).

4. Independence in learning.

5. Positive habits and attitudes toward his/her physical, mental and social health.

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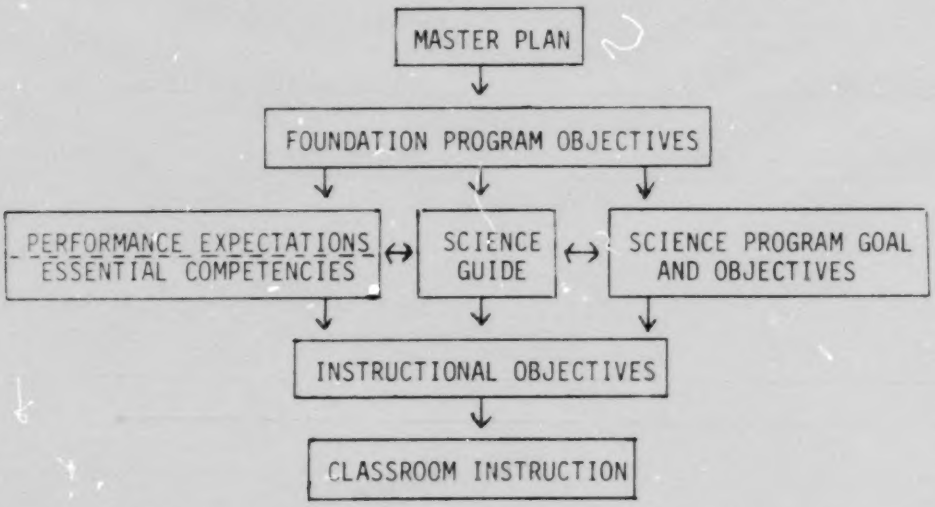
[2] Foundation Program Objectives for the Hawaii State Department of Education. Department of Education, April, 1974.

6. Realistic picture of the world of work and his/her own role in it.

7. A philosophy based upon values conducive to the development of sound character, moral, and ethical values.

8. Appreciation of beauty and motivation to create it.

A major aim of the Science Curriculum Guide is to promote the educational purposes as stated in the Master Plan for Public Education in Hawaii and the objectives of the Foundation Program for the Public Schools in Hawaii. To accomplish this intent, the design for the Guide uses statements of student performance expectations, including essential competencies, and the science program goal and objectives as translations of the educational purposes and objectives mentioned above. The performance expectations and essential competencies, the science program goal and objectives, and the Guide are together intended to foster the types of instructional objectives that can lead to classroom instruction which is scientifically authentic, based on sound principles of science education, and relevant and meaningful to students. The role of the Science Curriculum Guide in these relationships can be schematically diagrammed as follows:



RELATIONSHIP AMONG SCIENCE GUIDE, MASTER PLAN, FOUNDATION PROGRAM OBJECTIVES, PERFORMANCE EXPECTATIONS, ESSENTIAL COMPETENCIES, SCIENCE PROGRAM GOAL AND OBJECTIVES, INSTRUCTIONAL OBJECTIVES AND CLASSROOM INSTRUCTION.[3]

By viewing the Guide in this manner and understanding its rationale and development as an integrative tool for teachers to use in their day-to-day interactions with students, a closer approximation of a meaningful, helpful and truly functional Science Curriculum Guide has been achieved.

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[3]Student Performance Expectations of the Foundation Program. Department of Education, August 1978 (pg. 10). An adaptation of the chart presented therein.

OVERVIEW

The major purpose of science education is to insure that children have opportunities that lead to development as "scientifically literate adults." Achievement of scientific literacy will increase the individual's ability to cope with living in a society based on science and technology.

As defined by the National Science Teachers Association (NSTA), a scientifically literate person:*

1. Uses science concepts, process skills, and values in making everyday decisions as he/she interacts with other people and his/her environment.

2. Understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories.

3. Distinguishes between scientific evidence and personal opinion.

4. Identifies the relationship between facts and theories.

5. Recognizes the limitations as well as the usefulness of science and technology in advancing human welfare.

6. Understands the interrelationships between science, technology, and other facets of society, including social and economic development.

7. Recognizes the human origin of science and understands that scientific knowledge is tentative, subject to change as evidence accumulates.

8. Has sufficient knowledge and experience so that he/she can appreciate the scientific work being carried out by others.

9. Has a richer and more exciting view of the world as a result of his/her science education.

10. Has adopted the values similar to those that underlie science so that he/she can use and enjoy science for its intellectual stimulation, its elegance of explanation, and its excitement of inquiry.

11. Continues to inquire and increase his/her scientific knowledge throughout his/her life.

*NSTA Committee on Curriculum Studies "School Science Education for the 1970's". Science Teacher, The, Vol. 38, No. 8, pp. 46-51, November 1971. (Reprinted with permission from The Science Teacher, November 1971.)

This science curriculum guide consists of a continuum of fundamental skills and attitudes along which students progress from K-6, gradually strengthening their understanding of science. The skills and attitudes in this guide are as essential for the total education of our students as they are for science education because they serve as models for many of the fundamental skills and attitudes that our students need for a successful and full life.

Process skills (doing) and attitudes (feelings and values) are emphasized in this guide but not at the expense of content (knowledge of subject matter). Content serves as a vehicle for learning these skills and attitudes. It is the responsibility of each elementary school to assess its needs and on this basis select its science curriculum which will dictate specific content.

Section 1. GOAL AND OBJECTIVES. The first section of this guide deals with program goal and objectives and performance expectations. These are broad and general statements which are common to all grade levels (K-12) and differ only in the degree to which students in various grade levels attain them. The objectives are intended to serve as a basis for assessing and/or planning science curriculum in the schools. As such, they were written with the FOUNDATION PROGRAM OBJECTIVES FOR THE HAWAII STATE DEPARTMENT OF EDUCATION in mind.

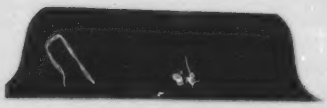
Section 2. SKILLS. This section deals with process skills which are an integral part of science education. These skills become more complex and sophisticated as children progress through the various grade levels. The basic process skills involve the direct and first-hand experiences of students as they use their five senses in making observations about biophysical phenomena and environments. Other skills include making qualitative and quantitative measurements, collecting and interpreting experimental data, formulating hypotheses, and designing and performing tests to validate ideas. Attainment of these skills will aid students in various decision making processes.

Section 3. ATTITUDES AND VALUES. This third section identifies student objectives in terms of feelings and values about science and scientists. The objectives deal with the development of a student's self-concept and attitudes toward the interaction among science, technology, and society. They encompass attitudes towards science--its aims, processes, values and limitations--and how science affects their lives. The objectives also focus on the "humanness" of scientists. Students' development of feelings, attitudes and values about science will be reinforced when attitudes exhibited by teachers are consistent with these objectives.

Section 4. ELEMENTARY SCIENCE CURRICULUM MODELS. The selected models presented in this section does not represent all the currently available models (programs), but rather only those that are most frequently used by schools in Hawaii. Schools are responsible for planning, selecting, and implementing a science curriculum program that meets the needs of their students and teachers.

Section 5. EXAMPLES OF K-6 FRAMEWORKS. This section presents K-6 Science Frameworks developed by teachers during the 1976 Elementary Science Summer Institute neld at McKinley High School and should serve as examples only. Hopefully, these examples will encourage you and your colleagues to develop a framework that works for your school.

Section 6. APPENDIX. The appendix includes the following topics: performance expectations, guidelines for selecting a program, helpful hints and other ideas, a student guide for projects, science laboratory safely and practices, resource materials, and glossary. It is intended to serve as a guide to teachers in assessing, planning, implementing, and evaluating the quality of science instruction in their classrooms.



SCIENCE PROGRAM GOAL AND OBJECTIVES

goal and objectives

performance expectations

SCIENCE PROGRAM GOAL AND OBJECTIVES

Science is just a way of interpreting and describing man's environment. Therefore, it is important for the science program to be directed toward satisfying the need for providing a "scientifically literate" population; that is, a body of citizens most of whom will never become scientists and who need to understand science better since they will be responsible for rating on science-related public issues as adults.

The many ideas of science can be studied in a number of ways--using various teaching styles and various programs. Therefore, the specific content of what is taught is unimportant. What is important is helping students realize that science shapes society. As future adult citizens, they must assist in shaping the future of science and the society of our choice by using "scientific logic".

As science teachers, we are faced with the awesome responsibility of deciding what are the important "goals" of science education. This section presents some broad and general statements that are considered to be basic for all grade levels, and differ only in the degree to which students in various grade levels attain them. These statements are intended to serve as a basis for assessing and/or planning <u>your</u> science curriculum for <u>your</u> school.

GOAL AND OBJECTIVES

GOAL AND OBJECTIVES

The purpose of science education "should be to develop scientifically literate citizens with the necessary intellectual resources, values, attitudes, and inquiry skills to promote the development of man as a rational human being".*

With this in mind, the science program objectives should be to:

1. Nurture in our children a curiosity and excitement about the bio-physical environment.

2. Teach students to value science as one way of learning and communicating effectively about self, others and the environment. (Develop a longing to know and understand.)

3. Facilitate development of interests, attitudes, personality, and creativity which enhance the continued development of individuality in the learner.

4. Facilitate children's ability to accept the existence of individuals who have ideas and values which are different from their own.

5. Foster the students' appreciation for the practical and aesthetic contribution of science to the improvement of quality of life and to promote in our students the desire to take an active part in that contribution.

6. Facilitate the students' ability to use scientific knowledge, processes, instruments and scientific language to clarify values, examine issues, solve problems in fulfilling personal, social and career life roles.

7. Foster the intellectual virtues that are characteristics of science such as honesty, objectivity, impartiality, open-mindedness, creativity, inventiveness, self-direction, and rationality.

8. Help students to analyze and synthesize holistically (using knowledge from various disciplines) in solving a problem.

9. Expose students to cross-cultural comparisons of critical bio-social issues, i.e., race relations, family structure, male-female roles, human resources and others.

10. Facilitate a positive self-concept through the development of self-pride and a sense of accomplishment by encouraging self-expression of conventional and unusual ideas as well as independence in learning.

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*NSTA Committee on Curriculum Studies, "School Science Education for the 1970's", Washington, D.C.: National Science Teachers Association, 1971. (Reprinted with permission from The Science Teacher, November 1971.)

11. Prepare the children for useful, effective citizenship in an increasingly complex and technological society by developing an interest in and a curiosity about the future both for themselves and for the civilization of which they are a part.

12. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

13. Develop in students, skills to seek and evaluate information using the inquiry process.

14. Foster the "spirit of inquiry" in the classroom.

15. Expose students to as many diversified science experiences as possible within the school year.

16. Teach science as a unified discipline integrated and/or coordinated with other disciplines such as math, social studies, language arts, art, etc.

17. Encourage students to maintain a safe and healthy environment.

PERFORMANCE EXPECTATIONS

The science program goal and objectives, as listed in the preceding section, correlate with the eight objectives of the Department's Foundation Program and provide the bases for student performance expectations. As partially displayed in this section, more fully in the Appendix of this Guide, and completely in the publication, Student Performance Expectations of the Foundation Program (1978), these student performance expectations for science were written using the recommendations, suggestions and ideas of many school, district and state personnel. They collectively represent the educational and scientific values subscribed to by science educators as worthy goals to pursue with students. However, it is necessary to emphasize at the outset that the performance expectation statements are a representative sample of a much larger body of statements that could have been written; that other equally worthy science education goals and objectives exist which individual teachers may choose to emphasize and include in this list; and that, like knowledge, process skills, values and attitudes which change over time, performance expectations are also tentative and subject to change.

Student performance expectations are also the distilled products of the values inherent in diverse educational statements that range from the Master Plan for Public Education in Hawaii to the singularly important and specific instructional objectives of the classroom science teacher. Whatever the source of the educational values used to write student performance expectations, it almost goes without saying that these values direct all attempts to improve the effectiveness of science programs. Ultimately, however, improvement of programs is dependent upon the quality of measures used to tell us the effectiveness of student performance in the science classroom.

Although measuring student performance is most meaningful to classroom instruction, it also has great significance for the rest of education because the expectations we hold for students can serve many other curricular functions. For example, they can accomplish the following:

1. Serve as guides for school and classroom planning of science curriculum and instruction;

2. Act as benchmarks or more specific targets for generating instructional objectives and designing and conducting instruction in science classrooms;

3. Help to translate global aims of the Department into specific instructional goals and objectives for science education;

4. Increase the teacher's control over science instruction while attending to the values and oftentimes changing emphases of scientific disciplines and the community-at-large;

5. Mediate discussions of curricular and/or instructional issues or problems for which no clear cut solutions exist;

6. Used in ways which we have not yet found a need to think about or address while trying to improve science programs and instruction.

The science teacher's classroom use of student performance expectations begins with the realization that all of the statements are interrelated; that no stated performance expectation exists exclusive of every other statement. Although in displaying the performance expectations they are clustered to group those statements which are most closely interrelated and arrayed according to designated grade levels, the attempt to interrelate a particular science performance expectation to every science-related statement was intentional by design. This can be seen more clearly if the teacher views the total collection as describing the student's performance profile for science. This profile of the student along with his/her degree of achievement in the four developmental areas important to science education (knowledge, process skills, attitudes, values) would tend to indicate the level of scientific literacy attained by a student. If science education is to contribute to the growth and development of students to enable them to perform and participate in activities that are scientific, then scientific literacy, as a goal defined in the preceding section of this Guide, is the primary task we focus on. It will not be adequate for the teacher, therefore, to view the generation of his/her instructional objectives on a one-to-one matching basis with each performance expectation statement. The teacher will also be required to see the relationship between performance expectations and instructional objectives and instruction in a countervening manner. Each of his/her instructional objectives and instructional activities must be perceived as contributing to student attainment of several performance expectations simultaneously.

In terms of students, performance expectations are cumulative and cross clusters and grade level designations. In terms of instruction, performance expectations integrate the what, when and how of the teaching act to attach meaning and relevance of the act for students. In terms of the interests of the discipline of science, performance expectations attempt to answer the why of science education.

Grade 3	Grade 6
• Answers questions related to directed science activities.	• Solves simple problems that require manipulation of objects and ideas.
• Acquires information that emerges from simple given scientific experiments.	• Asks appropriate questions to gather information needed to explain natural phenomena.
• Solves simple problems that require manipulation of objects and ideas.	• Uses a variety of sources to acquire information including information on file.
• Asks appropriate questions to gather information needed to explain natural phenomena.	• Records and reports simple quantitative and qualitative experimental data.
• Records and reports simple quantitative experimental data.	• Infers possible causes of an observed or represented effect.
• Infers possible causes of an observed or represented effect.	• Uses simple scientific measuring tools and equipment to solve problems.
• Uses simple measuring tools and equipment to solve problems.	• Cites examples of cause and effect relationship in nature.
• Cites examples of cause and effect relationships in nature.	• Defines a simple scientific problem or question to be investigated.
• Defines a simple scientific problem or question to be investigated.	• Uses drawings, graphs, and charts to analyze and communicate experimental information.
• Uses experimental information to recognize some simple quantitative and qualitative change patterns in observed phenomenon.	• Uses experimental information to recognize some simple quantitative and qualitative change patterns in observed phenomenon.
• Checks out reliability of information derived from a simple given scientific experiment.	• Checks out reliability of information derived from a simple given scientific experiment.
---	• Identifies actions and outcomes of a controlled experimental situation.
• Completes work in science with supervision.	• Analyzes experimental information and draws simple interpretations.
• Shows curiosity about natural phenomena.	• Uses interpretations of data to check out generalizability of experimental findings or to formulate generalizations.
• Identifies at least one way for finding answers to questions and for solving problems in science.	

Grade 3	Grade 6
• Asks questions to gather information needed to explain natural phenomena. • Uses a variety of sources to acquire information including information on file. • Summarizes retrieved information according to set purpose. --- • Follows health and safety precautions and rules while participating in science activities. • Identifies reasons for the necessity of health and safety precautions and rules while participating in science activities. • Identifies and describes health and safety practices to be followed and respected in conducting science activities. --- • Exhibits awareness of science as relevant to all persons. • Uses scientific knowledge and skills in every day situations. • Recognizes contributions of science and technology in shaping our world. --- • Demonstrates interest in science by participating in teacher-directed activities. • Works in group situations dealing with science activities. • Completes teacher-directed science assignments. • Demonstrates openness to other's point of view by revising science judgments when concrete data justifies this.	• Applies generalizations to appropriate interpretations of information. --- • Identifies at least one method for finding answers to questions and for solving problems in science. • Asks questions to gather information needed to explain natural phenomena. • Uses a variety of sources to acquire information including information on file. • Summarizes retrieved information according to set purpose. • Studies science-oriented materials independently and applies knowledge learned to solve scientific problems. • Conducts simple scientific experiments to explore given problems. --- • Identifies reasons for the necessity of health and safety precautions and rules while participating in science activities. • Identifies and describes health and safety practices to be followed and respected in conducting science activities. • Uses preventive approaches to health and safety practices while conducting science activities. --- • Uses scientific knowledge and skills in everyday situations. • Recognizes contributions of science and technology in shaping our world. • Demonstrates knowledge that scientific discoveries and technology affect the entire world of work.

Grade 3	Grade 6
	• Identifies various science-related vocations or professions. • Completes teacher-directed science assignments. • Demonstrates openness to other's point of view by revising science judgments when concrete data justifies this. • Works independently to pursue science assignments. • Works on group experiments taking responsibility for a share of the work. • Describes benefits of working alone or with others to solve scientific problems. • Shows understanding of the importance of his/her work and the work of others in science.

PROCESS SKILLS

observing
classifying
measuring
using space-time relationships
collecting and organizing data
graphing
inferring and predicting
making, selecting and testing hypotheses
identifying and controlling variables
model building
using equipment
using scientific vocabulary
communicating
thinking
process integration

PROCESS SKILLS

Process skills are the skills necessary for inquiry and problem-solving behaviors. These skills enable children to solve problems with a minimal amount of quidance. The process skills covered in this guide are: 1) observing; 2) classifying; 3) measuring; 4) using space-time relationships; 5) collecting, organizing, recording and interpreting data; 6) graphing; 7) inferring and predicting; 8) making, selecting, and testing hypotheses; 9) identifying and controlling variables; 10) model building; 11) using equipment; 12) using scientific vocabulary; 13) communicating; 14) thinking; 15) process integrating.

Each process skill has a number of objectives which should be mastered by the student. The "degree of mastery" of these objectives, and subsequent development of each process skill, depends not only on the abilities of the children but also upon the abilities of teachers. Teachers are responsible for providing adequate opportunities for students to develop "mastery" of process skills.

Inherent in all skills are attitudes as explored in the next section. This should not be overlooked. Attitudes are just as or more important than the acquisition of all process skills.

While it is recognized that reading and writing skills are also important parts of science, these skills are not treated separately. They are integrated as part of the enabling objectives for each process skill.

OBSERVING

Observing is a fundamental activity of scientists. Knowledge comes primarily from what we see, hear, taste, smell or touch. As children grow older and gain more experience, the details and accuracy of their observations increase. (Inference and opinions are not part of observing.)

Our science program should promote the observational skills by providing students with as much developmental experiences as necessary.

Students should be able to:

1. Identify objects and their properties using five senses.
2. Observe and describe changes in the properties of objects.
3. Identify differences and likenesses in a variety of objects.
4. Distinguish between statements of observations and inference.
5. Distinguish between statements of observations and opinions.
6. Use the appropriate language when describing an object or making an observation. (e.g. Is the object larger in length, width, weight?)
7. State observations in qualitative terms whenever possible.
8. State observations in quantitative terms whenever possible.

CLASSIFYING

The process of classifying involves the examination of two or more objects or events to note similarities and differences in their properties and the systematic arrangement of those objects or events into groups or categories according to those characteristic properties. The experience level determines to what extent classification skills can be carried out.

Our science program should promote the classification skills by providing as much developmental experiences as necessary.

Students should be able to:

1. Classify or sort objects or events through the identification of similarities and differences in their properties.

2. Sort objects into groups based on given or student-generated criteria.

3. Divide objects into groups in several different ways (several ways of classifying the same group of objects).

4. Divide objects into groups according to a hierarchical system by listing and identifying how many objects would be in a total set, given the properties of the objects in subsets and how many objects would be in each subset.

5. Organize and analyze classification matrices by arranging given objects in a given matrix.

6. Match one or more given subsystems with their corresponding systems.

7. Decide in what ways a group of objects are similar or different and then identify another group of objects that are similar or different in the same way.

MEASURING

Measuring is an activity that involves the comparison of certain properties of objects. It serves as a means of ordering events or objects. Measurement can be either qualitative or quantitative. The use of sophisticated tools of measurement as well as the accuracy of measurement is dependent upon the maturity and level of experience of the individual child.

Our science program should promote the measuring skills by providing as much developmental experiences as necessary.

Students should be able to:

1. Make a relative comparison of some property of two objects or events.
2. Order a group of objects or systems of objects from most to least or vice versa using some property of those objects or systems.
3. Use the appropriate instrument for making a particular measurement.
4. Select the appropriate units for making a particular measurement.
5. Measure some property of an object using arbitrary units.
6. Suggest and use "home-made" measurement units to measure the properties of objects.
7. Make a scale diagram.
8. Select and correctly use the appropriate measuring device to obtain measurements of time, distance, mass, volume, temperature or other physical quantities. (Metric units should be used wherever possible.)
9. Explain the limitations and/or degree of precision of common home and scientific laboratory devices.
10. Estimate and give relative measurements of time, length, mass, volume, space, and temperature.

USING SPACE-TIME RELATIONSHIPS

Skill in dealing with space-time relationships necessitates an understanding of relative position in space, mapping, relative motion, scaling and time.

Our science program should build for understanding of these concepts by providing students the necessary developmental learning experiences.

Students should be able to:

1. Identify a two-dimensional object.
2. Identify the shapes of various objects in their environment.
3. Identify a three-dimensional object.
4. Distinguish between figures that have symmetry and those that do not.
5. Demonstrate an understanding of points, lines, planes, spaces, and angles.
6. Describe or identify the position of an object relative to another object in terms of three referents: left-right, above-below, in front of-behind.
7. Identify the position of an object relative to several other objects at the same time.
8. Order a set of events in terms of the time order in which the events occurred.
9. Tell whether an object in a series has moved up, down, forward, backward, or left, right.
10. Describe the changes in the position of an object in reference to themselves or another object.
11. Describe how a scene would look like when viewed from a position other than their own.
12. Identify from a picture drawn in perspective the object which is closer to or farther away from a given point.
13. Read a distance scale on a map, and give the distance from one point to another.
14. Measure time in units appropriate for the activity--minutes, hour, day, year, season, etc.

15. Compare relative speed of objects in motion.

16. Draw a simple map of a scene to scale.

17. Use cardinal (principal) directions when identifying the route between given locations on a map.

18. Demonstrate an understanding of the coordinate system.

COLLECTING, ORGANIZING, RECORDING AND INTERPRETING DATA

Collecting and organizing data involve the recording of observations and sequencing or ordering the data. These skills may involve the organization of data in terms of graphs and data tables. At the earlier stages of development, the skills may call for picture stories, simple diagrams or a list of observations--qualitative observation. In the upper grades, the students may be doing graphing, histograms, and taking measurements that require a data table.

Our science program should provide the necessary experiences for our students to develop skills in handling and interpreting data.

Students should be able to:

1. Verbally communicate the properties of objects and observed changes.
2. Make picture stories and records of observations and investigations.
3. Make charts of classroom investigations.
4. Sequence observed changes in materials and systems both verbally and in writing.
5. Make simple diagrams of systems and investigations and label them.
6. Construct and/or use graphs and histograms to display and/or infer trends.
7. Organize collected observations and measurements in tabular form.
8. Represent and communicate data in written or verbal form.
9. Draw conclusions from a table or chart.
10. Locate and use "scientific" information.

GRAPHING

Graphing involves the ability to organize raw data into picture or chart form using a line graph, a tallygram, pictograph, circle graph, or bar graph.

Our science program should provide our students with the necessary experiences in graph construction to develop this skill.

Students should be able to:

1. Construct, label, and interpret pictographs and tallygrams.
2. Construct and label bar graphs from data given.
3. Summarize the meaning of bar graphs and identify relationships.
4. Construct and label a simple circle graph.
5. Summarize the meaning (draw conclusion or inference) of a circle graph and identify relationships.
6. Construct, label, and interpret simple line graphs.
7. Extrapolate and interpolate data from a graph.

INFERRING AND PREDICTING

Inference or inferring involves going beyond the information or evidence at hand to presume a cause or an effect, or to answer a question. Inference involves interpretation of observations.

Predictions are inferences about future events that have been developed through observation and testing of current events. Predicting involves the skill of making informed estimates of what should happen in a given situation, based on knowledge of what enters into the situation and on previous experience.

Our science program should provide our students with the necessary experiences to develop inferring and predicting skills.

Students should be able to:

1. Make a distinction between an observation and an inference.
2. Construct one or more inferences from observations.
3. Identify those observations which support an inference.
4. Demonstrate that inferences may need to be revised on the basis of additional and more recent observations.
5. Construct predictions based on data represented by a graph.
6. Test those predictions that have been made.
7. Construct or identify a test for a given inference.
8. Categorize statements as inferences, facts, or opinions.
9. Identify a prediction which could be made on the basis of a particular set of observations.
10. Interpolate and extrapolate information from data.

MAKING, SELECTING, AND TESTING HYPOTHESES

Formulating and testing a hypothesis involve selecting the most probable solution that may have a cause and effect relationship within the problem. It involves doing something to see what happens and then recording what happens.

Our science program should provide our students with many experiences in making and testing hypotheses in order to develop these skills.

Students should be able to:

1. Distinguish between statements that are hypotheses and those that are not.

2. Construct a hypothesis from a set of observations and inferences.

3. Devise and conduct a test or tests for the formulated hypothesis.

4. Identify or make a guess about the cause of an event.

5. Choose an appropriate type of apparatus to be used to test a given hypothesis.

6. Identify the degree of precision of measurement necessary for testing a simple hypothesis.

7. Suggest or identify a test which would support one hypothesis and weaken a competing hypothesis.

IDENTIFYING AND CONTROLLING VARIABLES

Variables are conditions that can differ from one experiment or investigation within a system to another. Handling variables involves observation skills in identifying and naming variables related to the investigation and the ability to design ways of controlling them.

Our science program should provide our students with many investigative/experimental experiences in order to help develop skills in identifying and controlling variables.

Students should be able to:

1. Name variables that have affected or may affect the outcome of an investigation.

2. Identify and name which variables should be controlled and manipulated in an investigation.

3. Identify and name the manipulated and responding (independent and dependent) variables in an investigation.

4. Construct a test for a hypothesis, inference or problem in which variables are identified.

5. State a rule that relates the responding variable(s) to the manipulated variable.

MODEL BUILDING

Model building involves graphics, objects, or dynamic representations of ideas about reality (e.g. chart, diagram, diorama, scale model, dramatization, etc.). On a simple level, models may merely be pictures explaining an idea or observation; on a higher level, it may involve a flow diagram or chart and, on an even higher level, it may represent a theory or a principle.

Our science program should provide our students with many model building experiences in order to develop this skill.

Students should be able to:

1. Represent a "scientific model" pictorially.
2. Identify or write an example of a model.
3. Identify characteristics of models (e.g. always made by people).
4. Identify uses of models.
5. Identify some advantages of models.
6. Identify two models which could explain the same phenomenon.
7. Construct a model.

USING EQUIPMENT

The proper use of equipment requires skills just as the inquiry processes do. Proper use and handling involve safety considerations. Mastery of the instruments involves effective and efficient use.

Our science program should provide our students with many hands-on experiences in the use of science equipment.

Students should be able to:

1. Properly store and maintain science equipment and supplies.
2. Maintain a safe and healthy classroom environment at all times.
3. Follow conventional procedures for effective use of science equipment.
4. Adapt or modify standard science procedures or equipment as needed but keeping safety in mind at all times.
5. Use science chemicals safely and effectively.
6. Use appropriate instruments for making a particular measurement or doing a particular experiment.
7. Recognize the appropriateness and limitations of certain science equipment.
8. Identify the names and functions of various instruments used in class.

USING SCIENTIFIC VOCABULARY

The proper use of scientific vocabulary involves using the appropriate terms to communicate ideas accurately and with efficiency and clarity.

Our science program should encourage students to use appropriate scientific vocabulary.

Students should be able to:

1. Recognize the need for standardization of scientific terms, symbols, and measurement units.

2. Understand that definitions of scientific terms may be modified.

3. Use accurate scientific names for organisms and objects.

4. Use measurement terms and symbols accurately for their level.

5. Use terms used in science accurately (e.g. hypothesis, prediction, etc.)

6. Use scientific terms specifically for the concept involved, (mass instead of weight, density instead of weight, etc.).

7. Locate and use resources for defining and clarifying scientific vocabulary.

COMMUNICATING

Communicative skills involve the ability to get ideas across to someone else in a clear, concise manner. It also involves such activities as listening, asking questions, sharing, writing, graphing, discussing, and reporting.

Our science program should provide our students with many opportunities to communicate ideas with others.

Students should be able to:

1. Listen objectively to reports given by others.
2. Ask questions to help clarify and/or expand on ideas.
3. Communicate feelings and values to the teachers and fellow students.
4. Share ideas with others through discussions and/or report giving, as well as, informally in "lab" groups.
5. Communicate and share ideas through written or oral reports.
6. Communicate and share ideas through graphs, drawings, or displays.
7. Check their perception of another person's feelings or intentions.
8. Participate effectively in group inquiries or problem solutions (e.g. contribute ideas, work cooperatively).

THINKING

An important skill for students is thinking. It involves being critical as well as creative. Extending students' skills in developing creative solutions to problems involve six levels of cognition.*

Students should be able to:

1. Recall or locate information.

2. Understand, not merely recall, facts learned. (This understanding may be demonstrated by the students' abilities to restate facts in their own words.)

3. Apply what is learned to a new situation--such as applying a generalization or principle to a new problem.

4. Analyze or "take apart" information to examine or work with different parts--ability to categorize.

5. Synthesize--create or invent something--by bringing together more than one idea or piece of information or skill.

6. Evaluate or judge when there is more than one possible point of view--giving reason or evidence to support the conclusion.

*Dr. Benjamin Bloom's six level of cognition (thinking).

PROCESS INTEGRATION

Process integration involves the ability to synthesize the knowledge, process skills, attitudes and values learned to solve problems. At the first level, it involves solving problems which are familiar. At the more advanced level, it involves the ability to utilize skills, knowledge and attitudes and apply them to a unique or original situation to solve a problem.

Our science program should provide our students with many problem-solving type experiences.

Students should be able to:

1. Construct and devise an investigation about observed phenomena, including the development of a hypothesis and operational definitions, and identification and control of variables.

2. Identify the other processes of science and mathematics as applied to the investigation.

3. Conduct and report in writing the results of the investigation.

ATTITUDES

AND

VALUES

ATTITUDES

Attitudes as used in this guide refer to feelings, values, beliefs and appreciations about something. Along with attitudes, there are behaviors which underlie their acceptance and practice. It is felt that unless teachers have these attitudes themselves, it would be very difficult to share them with others. Many of these attitudes are transmitted to students not through some formal lesson, but rather informally through everyday practice. The teacher must make these attitudes a part of the classroom atmosphere.

It is very important that we realize that attitudes do not exist in a vacuum or occur by themselves--attitudes are inherent to content and process skills learned, as well as the entire classroom and learning environment.

The attitudes and values listed in this section are by no means complete. However, they are some of the more basic attitudes and values that are important for the development of the student at the elementary school level.

Attitudes and Values	Evidence
1. Value and appreciate <u>themselves</u>.	Students demonstrate this feeling when they: a. take pride in their work by sharing it with others. b. are willing to continue experimenting in spite of repeated setbacks. c. set realistic goals for themselves. d. acknowledge their needs and interests. e. choose health practices which promote physical and emotional well-being. f. help others grow and develop. g. are willing to take risks. h. are aware of their strengths and weaknesses.
2. Value and appreciate <u>others</u>.	Students demonstrate this feeling when they: a. listen to other people's ideas. b. show respect for other people's property. c. work well with others individually and in groups. d. understand that every individual is different and unique. e. accepts others' feelings and show that they accept them. f. help others grow and develop.

Attitudes and Values	Evidence
3. Value and appreciate their environment.	Students demonstrate this when they: a. willingly contribute to school and community events. b. show respect for the environment. c. are aware of the harmony and orderliness in the environment. d. identify characteristics of their environment which they perceive as pleasing. e. wonder about the natural phenomena that take place daily in their lives.
4. Value critical-mindedness.	Students demonstrate this value when they: a. look for evidences to support or contradict explanations. b. ask many questions starting with what, where, why, when and how.
5. Value the need for evidence.	Students demonstrate this value when they: a. look for evidence to support or contradict explanations. b. collect as much data as possible before drawing conclusions.
6. Value honesty.	Students demonstrate this value when they: a. report observations even when these contradict explanations. b. acknowledge work done by others.

Attitudes and Values	Evidence
7. Value objectivity.	Students demonstrate this value when they: a. report and consider all observations even when these contradict their ideas. b. examine many sides including pros and cons of a problem.
8. Value willingness to change opinions.	Students demonstrate this value when they: a. recognize conclusions as being tentative. b. change their ideas when necessary to accommodate evidence.
9. Value open-mindedness.	Students demonstrate this value when they: a. consider ideas presented by others. b. consider several possible options when investigating a problem.
10. Value a questioning attitude.	Students demonstrate this value when they: a. ask many questions starting with who, where, why, when and how. b. challenge unsupported statements.
11. Value self-directedness.	Students demonstrate this value when they: a. plan and carry out a work schedule independently. b. use resource materials on their own initiative. c. work at a pace appropriate to their abilities. d. participate in class activities. e. perform additional experiments after "failure".

Attitudes and Values	Evidence
12. Value processes of scientific inquiry	Students demonstrate this value when they: a. show curiosity. b. use their senses to make observations. c. use measuring instruments and laboratory techniques to investigate problems. d. use the inquiry process in solving everyday problems.
13. Value and appreciate the achievements of science and technology	Students demonstrate this value when they understand that technology differs from science in that technology involves the means of building and doing useful things while the aim of science is the development of knowledge and understanding of nature.
14. Value scientists as human beings	Students demonstrate this value when they: a. understand that scientists are human beings and have the same human strengths, weaknesses, and emotions as people in other lines of work. b. can list many kinds of scientists. c. understand that scientists do not claim to know all the answers.
15. Value and appreciate science	Students demonstrate this attitude when they: a. can explain in what way science is systematic and consistent. b. are able to explain the effect (negative and positive) of science on their lives. c. understand that science can logically explain many observed phenomena based on facts and that science is not magic.

Attitudes and Values	Evidence
	d. understand that the "doubt and certainty" in science lead to more discoveries.
	e. understand that science and technology can contribute to the solution of many contemporary social, economic, and political problems.
	f. understand that science and technology have their limitations and in fact can and do cause contemporary social, economic, and political problems.
16. Value communication	Students demonstrate this value when they:
	a. listen to the ideas of others.
	b. are accurate in their communication to others.
	c. willingly participate in class discussions.

ELEMENTARY SCIENCE CURRICULUM MODELS

Department of Education Conceptual Model

Elementary Science Study (ESS)

Science...A Process Approach II (SAPA II)

Science Curriculum Improvement Study (SCIS and the new SCIIS)

Others

ELEMENTARY SCIENCE CURRICULUM MODELS

Several suggested elementary science curricula are presented in this section to serve as examples. It is not the intent of this section to dictate the use of any specific curriculum. It is the responsibility of teachers to select and/or develop a science program best suited to the needs of their students as well as their own.

A SUGGESTED CONCEPTUAL MODEL OF A SCIENCE PROGRAM*

*Taken from Curriculum Outline for Elementary School Science, State of Hawaii, Department of Education, 1968.

KINDERGARTEN

LIVING THINGS:

1. Some objects in the environment are living things.
2. The living world consists of plants and animals.
3. Living things are studied by making careful observations.
4. There are many different forms of plants and animals.
5. Humans are classified as animals.
6. Living things are identified by their properties.

EARTH-SPACE SCIENCE:

1. Some objects in the physical world are non-living things.
2. Non-living things are identified by their properties.
3. Non-living things may be in the form of solids, liquids, or gases.
4. The sun is a source of light and heat on earth.

MATTER AND ENERGY:

1. Matter exists as a gas, liquid, or solid.
2. Forms of matter have characteristic properties.
3. All matter is organized into units which vary in size.
4. A push or a pull is needed to move things.
5. Different sounds are made by vibrations of different objects.

GRADE 1

LIVING THINGS:

1. Different forms of living things have specialized structures.
2. Living things have many needs to grow and survive.
3. Livings things are affected by their environment.
4. Living things come from similar living things.

EARTH-SPACE SCIENCE:

1. The weather undergoes changes daily.
2. The sun is the source of energy on earth.
3. The earth is a planet in the solar system.
4. The rotation of the earth and its revolution around the sun cause changes on the earth.
5. The earth is made of air, water, and land.

MATTER AND ENERGY:

1. Objects can be grouped according to similarities and differences of their properties.
2. Matter can be changed from one phase to another.
3. Light and heat are forms of energy.
4. Movement of objects is due to the influence of forces.
5. Some substances have magnetic properties.

GRADE 2

LIVING THINGS:

1. Living things change within their own life span.
2. The parts of each living thing have a definite function.
3. Different kinds of living things live in different environments.
4. Some former living things are now extinct.

EARTH-SPACE SCIENCE:

1. Water moves from the earth into the atmosphere and returns to earth in the water cycle.
2. There are regular movements of the earth and moon.
3. The movements of the moon affect the earth's environment.
4. The landforms of the earth undergo constant change.

MATTER AND ENERGY:

1. Energy can be changed from one form to another.
2. The force of gravity pulls objects towards the earth.
3. Energy can be transferred by wave motion.
4. Sound is the result of vibrations of matter.
5. Light may be reflected or refracted.

GRADE 3

LIVING THINGS:

1. Green plants are food producers.
2. Animals are food consumers.
3. Adaptations contribute to the survival of living things in an environment.
4. Each environment has its own community of living things.

EARTH-SPACE SCIENCE:

1. Weather is the result of various conditions in the air each day.
2. Scientists use instruments to make accurate observations of the weather.
3. Weather and climatic changes are caused by different amounts of the sun's radiation received on earth.
4. Rocks are made up of minerals.
5. Soil is material formed from rocks and organic matter.

MATTER AND ENERGY:

1. Temperature is a property of a substance determined by the energy of motion of molecules.
2. Heat energy is transferred by radiation, conduction, and convection.
3. Matter undergoes physical change by gain or loss of heat.
4. Simple machines are devices used to do work more conveniently.
5. Work must be done to overcome friction.
6. Some simple machines provide mechanical advantage.

GRADE 4

LIVING THINGS:

1. Matter is continuously exchanged between living things and their environment.
2. Living things are grouped according to common characteristics and structure.
3. Animals may be classified according to their distribution in special environments.

EARTH-SPACE SCIENCE:

1. Weather is influenced by ocean currents and prevailing winds.
2. Weather and climate are affected by topography and latitude.
3. The celestial bodies in the solar system influence the environment on earth.
4. The surface of the earth is constantly changing due to internal and external forces.

MATTER AND ENERGY:

1. Matter is made up of atoms and molecules.
2. An element is the simplest form of matter.
3. Matter exists as elements, compounds, or mixtures.
4. Combustion requires fuel, oxygen, and kindling temperature.
5. Objects in motion tend to remain in motion unless changed by an outside force.
6. Mechanical energy and chemical energy may be transformed into electrical energy.
7. Electrical energy occurs as static and current electricity.

GRADE 5

LIVING THINGS:

1. Cells are the basic unit of living things.
2. All living matter is made up of protoplasm.
3. There is great variety among microscopic organisms.
4. Living things are interdependent with other living things and their environment.

EARTH-SPACE SCIENCE:

1. The movement and interaction of air masses cause changes in the weather.
2. Storms are violent weather changes.
3. The earth's surface is constantly being built up and leveled by geologic forces.
4. Man can conserve natural resources and maintain a fit environment through proper conservation practices.
5. Stars and galaxies are a part of the universe.

GRADE 5 (cont'd.)

MATTER AND ENERGY:

1. In a chemical or physical change, the total amount of matter remains the same.
2. All molecules are in constant motion.
3. A magnetic field surrounds an electric current.
4. Electrical energy can be transformed into other forms of energy.
5. People use and control sound waves.

GRADE 6

LIVING THINGS:

1. Reproduction is a fundamental biological process for the continuance of life.
2. An organism is the product of heredity and its environment.
3. New types of living things can be produced by selected breeding.
4. People use their intelligence to adapt to changes in the environment.

EARTH-SPACE SCIENCE:

1. Weather is predicted through accurate observations of conditions in the atmosphere.
2. Water in the oceans is constantly moving and undergoing changes.
3. The oceans contain natural resources of minerals and biological life.
4. The movement of space exploration vehicles are influenced by the same forces which affect celestial bodies.
5. The environment in space is very different from the earth's environment.

MATTER AND ENERGY:

1. All matter can be reduced to its fundamental particles.
2. In nuclear changes, some matter is changed into energy.
3. Electricity is a source of energy for some chemical changes.
4. Electrical energy can be transformed into other forms of energy.

ELEMENTARY SCIENCE STUDY (ESS)

ELEMENTARY SCIENCE STUDY (ESS)

The program developers believe that learning about science should be based upon student involvement with reality. Therefore, the objective is to involve the student in doing, investigating and trying things on his/her own; it is expected that the outcome will be increased understanding, appreciation of scientific objectivity and a better self-concept.

Grade-Range	Subject Area	Unit
K-3	phys.	Light and Shadows
K-3	gen.skl.	Match and Measure
K-3	phys.	Printing
K-4	bio.	Animals in the Classroom
K-4	bio.	The Life of Beans and Peas
K-4	phys.	Mobiles
K-5	bio.	Butterflies
K-6	bio.	Eggs and Tadpoles
K-8	gen.skl.	Geoblocks
K-8	gen.skl.	Pattern Blocks
K-8	gen.skl.	Attribute Games and Problems
K-8	gen.skl.	Tangrams
K-8	gen.skl.	Musical Instrument Recipe Book
K-3	bio.	Growing Seeds
1-2	phys.	Spinning Tables
1-4	bio.	Brine Shrimp
1-4	bio.	Changes
1-8	gen.skl.	Mirror Cards
K-4	gen.skl.	Primary Balancing
2-3	phys.	Sand
2-6	gen.skl.	Structures
2-7	phys.	Sink or Float
2-6	phys.	Clay Boats
3-4	phys.	Drops, Streams, and Containers
3-4	phys.	Mystery Powders
3-5	phys.	Ice Cubes
3-6	phys.	Colored Solutions
1-7	bio.	Pond Water
3-7	earth	Rocks and Charts
3-7	bio.	Starting From Seeds
3-7	earth	Where is the Moon
3-8	bio.	Mosquitoes
3-6	gen.skl.	Whistles and Strings
4-6	bio.	Animal Activity
2-6	phys.	Batteries and Bulbs
4-6	bio.	Bones
4-6	bio.	Budding Twigs
4-6	bio.	Crayfish
4-6	bio.	Earthworms
4-6	phys.	Optics
4-6	bio.	Small Things

ELEMENTARY SCIENCE STUDY (ESS) (Contd.)

Grade-Range	Subject Area	Unit
4-6	bio.	Tracks
4-8	bio.	Microgardening
4-8	bio.	Behavior of Mealworms
4-8	gen.skl.	Peas and Particles
4-8	phys.	Pendulums
4-8	phys.	Senior Balancing
4-8	earth	Stream Tables
4-8	phys.	Water flow
5-7	phys.	Heating and Cooling
5-7	gen.skl.	Mapping
5-8	phys.	Balloons and Gases
5-8	phys.	Batteries and Bulbs II
5-8	earth	Daytime Astronomy
5-8	phys.	Gases and "Airs"
6-8	phys.	Kitchen Physics

Teacher Resources:

The ESS Reader — A Working Guide to the Elementary Science Study

ESS Newsletter — A Materials Book for the Elementary Science Study

DOE Approved Instructional Materials, Book I

SCIENCE ... A PROCESS APPROACH II (SAPA II)

SCIENCE--A PROCESS APPROACH II (SAPA)

The program develops student competence in carrying out science activities. The content changes periodically, but the processes and skills of scientific inquiry remain substantially the same. These processes and skills can be easily identified and taught in a systematic way from the simple to the complex.

The 105 modules of SAPA II can be grouped into seven components, each with 15 modules. Every component contains a balance of life and physical sciences. Kits consist of hardware, printed materials, teacher instruction book, and sufficient expendable materials for 30 pupils.

Module Number	Module	Process	Module Number	Module	Process
1	Perception of Color	Observing/a	43	A Plant Part That Grows	Communicating/e
2	Recognizing and Using Shapes	Space/Time/a	44	Surveying Opinion	Predicting/b
3	Color, Shape, Texture, and Size	Observing/b	45	Lines, Curves, and Surfaces	Space/Time/g
4	Leaves, Nuts, and Seashells	Classifying/a	46	Observations and Inferences	Inferring/c
5	Temperature	Observing/c	47	Scale Drawings	Communicating/f
6	Direction and Movement	Space/Time/b		A Tree Diary	Communicating/g
7	Perception and Taste	Observing/d	48	The Bouncing Ball	Predicting/c
8	Length	Measuring/a	49	Drop by Drop	Measuring/i
9	Sets and Their Members	Using Numbers/a	50	The Clean-Up Campaign	Predicting/d
10	Spacing Arrangements	Space/Time/c	51	Rate of Change	Space/Time/h
11	Listening to Whales	Observing/e	52	Plants Transpire	Inferring/d
12	Three-Dimensional Shapes	Space/Time/d	53	The Suffocating Candle	Predicting/e
13	Numerals, Order and Counting	Using Numbers/b	54	Static and Moving Objects	Measuring/j
14	Animal and Familiar Things	Classifying/b	55	Sprouting Seeds	Observing/m
15	Perception of Odors	Observing/f		Magnetic Poles	Observing/n
16	Living and Nonliving Things	Classifying/c	56	Punch Cards	Classifying/f
17	Change	Observing/g	57	Position and Shape	Communicating/h
18	Using the Senses	Observing/h	58	Liquids and Tissue	Inferring/e
19	Soils	Observing/i	59	Metersticks, Money, and Decimals	Using Numbers/e
20	Counting Birds	Using Numbers/c	60	Relative Motion	Space/Time/i
21	Weather	Observing/j	61	Circuit Boards	Inferring/f
22	Same but Different	Communicating/a	62	Climbing Liquids	Controlling Variables/a
23	Comparing Volumes	Measuring/b	63	Maze Behavior	Interpreting Data/a
24	Metric Lengths	Measuring/c	64	Cells, Lamps, Switches	Defining Operationally/a
25	Introduction to Graphing	Communicating/b	65	Minerals in Rocks	Interpreting Data/b
26	Using a Balance	Measuring/d	66	Learning and Forgetting	Controlling Variables/b
27	Pushes and Pulls	Communicating/c	67	Identifying Materials	Interpreting Data/c
28	Molds and Green Plants	Observing/k	68	Field of Vision	Interpreting Data/d
29	Shadows	Space/Time/e	69	Magnification	Defining Operationally/b
30	Addition through 99	Using Numbers/d	70	Conductors and Nonconductors	Formulating Hypotheses/a
31	Life Cycles	Communicating/d	71	Soap and Seeds	Controlling Variables/c
32	A Terrarium	Classifying/d	72	Heart Rate	Controlling Variables/d
33	What's Inside	Inferring/a	73	Solutions	Formulating Hypotheses/b
34	About How Far?	Measuring/e	74	Biotic Communities	Defining Operationally/c
35	Symmetry	Space/Time/f	75	Decimals, Graphs, and Pendulums	Interpreting Data/e
36	Animal Responses	Observing/l			
37	Forces	Measuring/f			
38	Using Graphs	Predicting/a			
39	Solids, Liquids, and Gases	Measuring/g	76	Limited Earth	Interpreting Data/f
			77	Chemical Reactions	Controlling Variables/e
40	How Certain Can You Be?	Inferring/b	78	Levers	Formulating Hypotheses/c
41	Temperature and Thermometers	Measuring/h	79	Animal Behavior	Formulating Hypotheses/d
			80	Inertia and Mass	Defining Operationally/d
42	Sorting Mixtures	Classifying/e	81	Analysis of Mixtures	Defining Operationally/e

Module Number	Module	Process
82	Force and Acceleration	Controlling Variables/f
83	Chances Are	Formulating Hypotheses/e
84	Angles	Interpreting Data/g
85	Contour Maps	Interpreting Data/h
86	Earth's Magnetism	Interpreting Data/i
87	Wheel Speeds	Interpreting Data/j
88	Environmental Protection	Defining Operationally/f
89	Plant Parts	Defining Operationally/g
90	Streams and Slopes	Interpreting Data/k
91	Flowers	Defining Operationally/h
92	Three Gases	Formulating Hypotheses/f
93	Temperature and Heat	Defining Operationally/i
94	Small Water Animals	Controlling Variables/g
95	Mars Photos	Interpreting Data/l
96	Pressure and Volume	Experimenting/a
97	Optical Illusions	Experimenting/b
98	Eye Power	Experimenting/c
99	Fermentation	Experimenting/d
100	Plant Nutrition	Experimenting/e
101	Mental Blocks	Experimenting/f
102	Plants in Light	Experimenting/g
103	Density	Experimenting/h
104	Viscosity	Experimenting/i
105	Membranes	Experimenting/j

SCIENCE CURRICULUM IMPROVEMENT STUDY

(SCIS and SCIIS)

SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS)

The SCIS program goal is to enable students to construct their own framework of concepts, to relate these concepts to their own experiences and to extend their understanding and involvement with the processes of scientific investigation. Within the classroom, students "explore" materials presented by the teacher; the teacher then "invents" a concept to explain what happened, and encourages students to "discover" the concept in other ways.

Grade	Physical Science Sequence	Life Science Sequence
Kindergarten	Beginnings	
1	Material Objects	Organisms
2	Interaction and Systems	Life Cycles
3	Subsystems and Variables	Populations
4	Relative Position and Motion	Environments
5	Energy Sources	Communities
6	Models: Electric and Magnetic Interactions	Ecosystems

Teacher Resources:
- SCIS Elementary Science Sourcebook
- SCIS Teacher's Handbook
- What Is Curriculum Evaluation - Six Answers
- SCIS Newsletter
- DOE Approved Instructional Materials, Book I

K

BEGINNINGS

CONCEPTS

color
shape
texture
odor
sound
size
quantity
position
organisms

OVERVIEW

The Beginnings unit for kindergarten and early childhood education offers a wide variety of activities and experiences in both life and physical sciences. The suggested small-group learning situations are geared to short attention spans. Children learn to observe, discriminate, and describe, using objects and organisms in the classroom and outdoors. These early experiences help them develop language and participation skills and contribute to their growing understanding of science. The unit leads into either the PHYSICAL/EARTH SCIENCE or LIFE/EARTH SCIENCE sequence.

RAND McNALLY SCIIS OVERVIEWS AND CONCEPTS CHART

LEVEL — PHYSICAL/EARTH SCIENCE

1

Material Objects

CONCEPTS

object
property
material
serial ordering
evidence

OVERVIEW

The children handle, observe, and describe objects. They learn that objects are composed of materials and have properties by which the objects can be discriminated; that some objects are solids, while others are liquids or gases; that objects can change; and that there are ways to recognize evidence of change. Property comparison leads to the concept of serial ordering. As the children investigate the properties of various materials, they realize that the same substance can exist in more than one form and they gain an awareness of the principle of conservation of matter.

2

Interaction & Systems

CONCEPTS

interaction
evidence of interaction
system
interaction at a distance

OVERVIEW

The concept of interaction is introduced as well as the concept that related objects or parts comprise a system. Students observe a variety of interactions, some of which are directly observable, others less apparent. The recognition that an interaction has taken place comes from the evidence that a change in the system has occured. The children investigate gear/pulley systems, chemical systems, magnetic systems, and electric circuits to observe and interpret evidence of interaction.

3

Subsystems & Variables

CONCEPTS

subsystem
solution
evaporation
histogram
variable

OVERVIEW

The subsystem concept is introduced to give the children a grouping of objects intermediate between a single object and an entire system. The children's work with solid and liquid materials extends their understanding of the subsystem concept. They learn that filtering will separate an undissolved solid from a liquid, but that solids dissolved in solutions must be identified by the residue that remains after the liquid evaporates. Histograms are used to record and interpret data collected by the students. The variable concept helps them to identify and investigate factors influencing their experiments.

4

Relative Position & Motion

CONCEPTS

reference object
relative position
relative motion
polar coordinates
rectangular coordinates

OVERVIEW

The ideas and techniques developed in this unit are related to concepts of earth and space science. Students find that descriptions of position and motion are meaningful only if reference to objects and coordinate systems--both polar and rectangular--are included in the descriptions. An artificial observer, Mr. O, serves the children as an introductory reference object. They see that reference to different objects and coordinate systems lead to different descriptions of position and motion. They also learn to use a variety of reference frames to describe the position and motion of objects in their everyday environment.

5	Energy Sources CONCEPTS energy source energy receiver energy transfer energy chain	OVERVIEW The concepts of energy source, energy transfer, and energy receiver constitute the core of the unit and are illustrated with experiments exploring mechanical and thermal systems. The importance of solar energy to meet some of our needs is emphasized in this unit. The children's descriptions of the amounts of energy transfered from a source to a receiver help them for understanding and applying the principle of conservation of energy.
6	Scientific Theories CONCEPTS scientific theory color magnetic field electricity light ray	OVERVIEW The extended investigations and formulation of scientific theories in this unit conclude the PHYSICAL/EARTH SCIENCE sequence. In Scientific Theories, children create their own theories to explain their observations of colored light, magnetic interactions, electric circuits, and simple ray optics. Investigations provide opportunities for students to think of theories to explain the operation of systems of interacting objects and to devise tests to distinguish among alternate proposals. In doing so, they gain a deeper understanding of how scientists work.

RAND McNALLY SCIIS OVERVIEWS AND CONCEPTS CHART

LEVEL	LIFE/EARTH SCIENCE	
1	Organisms CONCEPTS organism birth death habitat food chain decay	OVERVIEW The stage is set for the unit as children plant seeds, watch the growth of the seedlings, and experiment to see how external conditions affect growth. Their observations are extended to a model ecosystem--an aquarium. They observe changes that occur in the aquarium, including the growth of plants and animals, animals feeding on plants, animals eating other animals, birth, death, and decay. Experiences with classroom plants and aquariums give children a general introduction to the overall theme of the LIFE/EARTH SCIENCE units: interaction of organisms with their environments.
2	Life Cycles CONCEPTS growth development life cycle genetic identity plant and animal metamorphosis	OVERVIEW Focus is shifted from the ecosystem as a whole to some of its important parts--individual plants and animals. Through experiences with living, dead, and nonliving objects, the children have an opportunity to learn these classifications of objects around them. Living and dead organisms are further subdivided into plants and animals. By observing live, growing, developing, reproducing plants and animals, the children become aware of the fact that living objects have life cycles.
3	Populations CONCEPTS population plant-eater food web biotic potential animal eater plant-animal-eater predator-prey	OVERVIEW The children learn that the individual plants and animals they observed in Life Cycles live together in nature in groups. They build, maintain, and observe terrariums and aquariums, and investigate the interactions of populations contained within each system. By observing the interacting populations, they gain some understanding of food relationships. The consepts of biotic potential can e inferred after the pupils are asked to imagine, with the help of prepared charts, what could happen in a population if reproduction continued without any deaths.

4

Environments

CONCEPTS

environment
environmental factors
biotic
abiotic
range
optimum

OVERVIEW

The environment of an organism consists of biotic factors, which include all the other plants and animals living in the same area; it also includes abiotic factors, such as light, temperature, air, water, and soil. The children experiment with both plants and animals to discover the effects of changing various factors, the ranges of conditions tested for each factor and the optimum part of a range for each organism. On the basis of data collected from these experiments, students build terrariums with suitable environments for the organisms. They discuss and plan a human environment that includes other organisms on which humans depend.

5

Communities

CONCEPTS

pyramid of numbers
raw materials
reproduction
community
producers
consumers
decomposers
photosynthesis
food transfer
competitors

OVERVIEW

In Communities, emphasis is placed upon interactions among different populations of organisms, the most important of which concerns food. Students examine the interdependent relationship among plants (as producers), animals (as consumers) and microorganisms (as decomposers). The children investigate the capacity of green plants to produce food. They build terrariums containing plants, crickets, and salamanders, and observe the food-chain relationships. And they observe the results of decomposition after burying dead crickets in moist sand.

6

Ecosystems

CONCEPTS

ecosystem
water cycle
oxygen-carbon dioxide cycle
pollution
food-mineral cycle

OVERVIEW

The cycle concept is introduced by means of experiments with evaporation and condensation of water, leading to an understanding of the water cycle. Students learn that the ecosystem is maintained by the intake of energy from the sun and the continuous recycling of materials between organisms and the environment that surrounds them. Ecosystems are seen to include all the concepts in the LIFE/EARTH SCIENCE sequence as children see the pattern of ecosystems in North America and identify their own ecosystem. Changes in the balance in natural ecosystems, including those caused by pollution, are studied.

OTHER AVAILABLE ELEMENTARY SCIENCE PROGRAMS

UNIFIED SCIENCE AND MATHEMATICS FOR ELEMENTARY SCHOOLS (USMES)

The goal of the project is to develop 35 or more units from which school planners can design a flexibly integrated curriculum for grades one to six. All activities in USMES units are initiated by the students in response to a long range challenge. For example, their Design Lab provides resources, tools, and supplies, so that children can construct their own measuring tools, testing apparatus and models. Their "How To" cards give information to students about a specific skill; students read the cards when there is a need for a specific skill.

Implementation Units	Development Units
Burglar Alarm Design	Playground Design
Describing People	Weather Prediction
Lunch Lines	Electromagnetic Device Design
Pedestrian Crossings	Communication
Dice Design	Human Learning
Designing for Human Proportions	Highway Cloverleaf Design
Consumer Research	Classroom Design
Soft Drinks Design	Urban Planning

Teacher Resources:
The USMES Guide
Design Lab Manual
Technical Background Papers
Teacher Logs

For further information:
Educational Development Center
55 Chapel Street
Newton, Massachusetts

Director:
Professor Earle Lomon
Department of Theoretical Physics
Massachusetts Institute of Technology

ENVIRONMENTAL STUDIES PROJECT (ES)

The ES Project promotes student-centered or open learning environments. Students explore the content in their immediate environments--within and outside the classroom. Focusing primarily on affective education, it presumes that cognitive growth will be inevitable with a natural integration of science, social science, and the humanities. Use of these teacher materials can help promote an atmosphere of trust in order to effectively use other curriculum projects.

ES Packets 1 and 2

ES Packets 3 and 4

Teacher Resources: ESsence/se, a teacher's "non guide"
ESsence/se 2
Poster packet (10 posters that deal with the human side of education)
The Cutting Edge, Vol. 1 and 2 (Subtitle: How to Innovate and Survive)

Supplementary Textbook Series for Grades K-6

Most school science programs are directed toward student manipulation of materials where supplementary textbooks can prove to be invaluable resources or aids. As an outgrowth of "messing about", students often need added information which can be obtained from supplementary texts.

Grade	Title
K-6	Atkin: Ginn Science Program, 1975
1-6	Barnard: Macmillan Science Series, 1970
K-6	Brandwein: Concepts In Science, Harcourt, 1975
1-6	Rockcastle: Elementary School Science Series, STEM Addison Wesley, 1975
K-6	Schneider: Health Science Series, 1973
1-6	Smith: Modern Science Series, Laidlaw, 1972

Teacher Resources: DOE Approved Instructional Materials, Book I

EXAMPLES OF K-6 SCIENCE FRAMEWORK

Pearl Ridge Elementary School
K-6 Science Framework (ESS)

A Suggested SAPA K-6 Science
Framework

A Suggested SCIS Supplemented
K-6 Science Framework

EXAMPLES OF K-6 SCIENCE FRAMEWORK

Several suggested K-6 Science Frameworks prepared by teachers are presented in this section. They are examples only and are not intended to limit the teacher's and/or school's sense of responsibility and freedom in being selective regarding the choice of ability, needs, and interests of students.

A SUGGESTED ESS SUPPLEMENTED K-6 FRAMEWORK

Compiled by:

Marie Ann Kohara
Pearl Ridge Elementary School

PEARL RIDGE ELEMENTARY SCHOOL K-6 FRAMEWORK - SCIENCE

The following science programs have been selected for utilization in grades K-6 at Pearl Ridge Elementary School:

K-6 - Elementary Science Study (ESS)

Hawaii Nature Study Units

5-6 - Unified Science and Mathematics for the Elementary School (USMES)

Camp Erdman Outdoor Education Program

The ESS Program is complemented with the USMES program in grades 5-6. USMES is multidisciplinary and process skills oriented (including skills in decision making and evaluating).

The Hawaii Nature Study units and the Camp Erdman Outdoor Education Program were selected to provide program balance by using topics from the earth sciences and environmental studies.

PEARL RIDGE ELEMENTARY SCHOOL

ELEMENTARY SCIENCE STUDY PROGRAM

	Year I	Year II	Physical Science	Biological Science	Earth Science	General Skills
Grades K-1 (Pod J-1 and Room P-1)						
Growing Seeds	X	X		X		
Animals in the Classroom	X	X		X		
Pattern Blocks	X	X				X
Geo Blocks	X	X				X
Mirror Cards	X	X	X			
Changes	X			X		
Butterflies	X			X		
Match and Measure	X					X
Lights and Shadows		X	X			
Eggs and Tadpoles		X		X		
Sink and Float		X	X			
Grades 2-3 (Pod J-2 and Room P-4)						
Brine Shrimp	X			X		
Magnetism and Electricity (Silver Burdett Kit)	X		X			
Drops, Streams, Containers	X		X			
Life Cycle of Chicks (McGraw-Hill Continuity of Life Kit)	X			X		
Primary Balancing (For Ewa team)	X					X
Attribute Games (For Ewa team)	X					X
Clay Boats (For D.H. team and P-4)	X		X			
Mobiles	X		X			
Life of Beans and Peas		X		X		
Hawaii Nature Study: Plants, Insects		X		X		
Sea Life		X		X		
Primary Balancing (For D.H. team and P-4)		X				X
Attribute Games (For D.H. team and P-4)		X				X
Clay Boats (For Ewa team)		X	X			
Grade 4 (Pod C-1)						
Tangrams	X	X				X
Mystery Powders	X	X	X			
Crayfish	X	X		X		
Colored Solutions	X	X	X			
Pond Water	X	X		X		
Grade 5 (Pod C-1)						
Peas and Particles	X	X				X
Small Things (Part I)	X	X		X		
Starting from Seeds	X	X		X		
Bones	X	X		X		
Musical Instruments	X	X				X
Whistles and Strings	X	X				X
Batteries and Bulbs I	X	X	X			
Rocks and Charts	X	X			X	
Earthworms	X	X		X		

PEARL RIDGE ELEMENTARY SCHOOL

ELEMENTARY SCIENCE STUDY PROGRAM

SCIENCES

- [PS] Physical
- [BS] Biological
- [ES] Earth
- [GS] General Skills

PROCESS SKILLS

1. Observing
2. Classifying
3. Measuring
4. Using space-time relationships
5. Collecting, organizing, recording, interpreting data
6. Graphing
7. Inferring and predicting
8. Identifying-controlling variables
9. Making, selecting, testing hypotheses
10. Process integration
11. Model building

Grades 5-6 (Pod C-2)		1	2	3	4	5	6	7	8	9	10	11
Year I Units:												
Batteries and Bulbs I, II	PS							X			X	
Small Things	GS	X	X	X		X					X	
Behavior of Mealworms	BS					X			X	X		X
Mapping	ES			X		X						
Optics	PS										X	
Year II Units:												
Kitchen Physics	PS										X	
Structures	GS		X	X				X		X		X
Mosquitoes	BS	X				X			X	X		
Senior Balancing	PS			X		X		X				
Microgardening	BS										X	

Year I units alternate with Year II units.

UNIFIED SCIENCE AND MATHEMATICS FOR THE ELEMENTARY SCHOOL
(USMES)

USMES Philosophy:

An USMES unit is based on a challenge which presents children with a problem that is both real and practical, meaningful and stimulating.

Challenge:

The challenge states the problem and provides a goal or focal point. A challenge can be introduced in several ways:

1. Direct introduction arising from spontaneous discussion on a recent problem or event.

2. May arise during work on another USMES challenge.

3. May arise during work on another subject.

4. May arise during the discussion of a broader problem (cluster approach).

Skills to be Developed by the Children:

1. Defining a problem

2. Observing

3. Measuring

4. Collecting and analyzing data

5. Judging, formulating, and testing possible solutions

6. Decision making (of final course of action)

7. Evaluation of their final decision(s)

Strategy - Problem Solving:

1. The students reword the challenge in specific terms to make the problem applicable to their situation and list their criteria.

2. The class decides on their grouping, on the activities required by the challenge and on the division of labor.

3. The overall activities are conducted through discovery-learning experiences.

4. Directed learning is needed for continuance of investigations. Different resources are available to enable children to acquire these facts and skills: the How-to-Cards and the Design Lab (a central location of tools and materials and a work area where devices are constructed).

HAWAII NATURE STUDY

During the 1977-78 school year, the science committee will meet to articulate and coordinate their Hawaii Nature Study units for optimum implementation.

A SUGGESTED SAPA K-6 FRAMEWORK

Compiled by:

Lily Harada	Shafter Elementary
Judi Kobayashi	Kaimiloa Elementary
Marilyn Kunukau	Wahiawa Elementary
Kris Saiki	Waimalu Elementary
Yvonne Toma	Kipapa Elementary

AN ORIENTATION TO SCIENCE: A PROCESS APPROACH (SAPA)

The attached guide describes a sample K-6 science continuum using the activities in Science: A Process Approach (SAPA). The activities were recommended primarily on the basis of high student interest and teacher success. Exercises indicated by an asterisk (*) were found to be the most successful.

In SAPA, there are eight basic processes and four integrated processes. The basic processes are observing, classifying, measuring, inferring, using numbers, communicating, predicting, and using space/time relationships. The integrated processes are defining operationally, controlling variables, interpreting data, and formulating hypotheses.

Observing	Obs.	Involves the use of any of the five senses to provide information to the brain
Classifying	Class.	Is a way of imposing order on a collection of objects or events
Measuring	Meas.	Is the way students quantify measurements
Inferring	Inf.	Means drawing conclusions from what we observe
Using Numbers	Num.	Is essential for any quantifying we do
Communicating	Comm.	Involves words, diagrams, maps, graphs, equations, and other visual methods
Predicting	Pred.	Means making a forecast of what a future observation will be
Using Space/Time Relationships	S/T Rel.	Involves a description of spacial relationships and their changes with time
Defining Operationally	Def. Op.	Means to define something in the context of experience
Controlling Variables	Con. Var.	Means managing the conditions of an investigation
Interpreting Data	Int. Data	Involves using data to make, communicate, infer, and predict
Formulating Hypothesis	Form. Hyp.	Means making a generalization that includes all objects or events of the same class

SAPA I - PART A

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
K	k	Meas.	Beginning Measurement	Measuring is limited to comparing lengths of 2 objects, by using a single standard for measuring (the meter stick)
	b	S/T Rel.	Recognizing and Using Shapes	Developing the ability to recognize and name common two dimensional shapes
	*c	Obs.	Observing Color, Shape, Texture, Size	With spheres and cubes, students will learn to identify objects on the basis of 2 or more characteristics and to make careful, thoughtful, visual and tactile observations
	*d	Class.	Classifying Leaves, Nuts, or Shells	With a choice of either leaves, nuts or shells, students sort, arrange and classify on the basis of similarities and differences
	h	S/T Rel.	Observing Movement	Students will observe movement of both living and nonliving things and identify the direction of movement
	*i	Obs.	Perception of Sound	Students make observations by hearing and listening to sounds as a way of learning about one's environment
	*j	Obs.	Observing Color Changes	Students will match and name colors, observe and name colors in a situation in which colors change
	l	Num.	Order Properties	Working with several sets of objects, students will recognize what it means for one set to have a certain number of members and another set to have a different number of members. Thus, introducing the notion of the number of a set
	o	S/T Rel.	Shapes and Their Compartments	Introduces students to relationships between two-dimensional and three-dimensional shapes. Also introduces some common, regular three-dimensional shapes
	*q	Obs.	Perception of Odor	Extends the students powers of observation by developing their ability to use their sense of smell to identify and classify odors
	*r	Obs.	Perception of Taste	The sense of taste is introduced here (only in relation to food substances) to complete the sources of direct sensory descriptions of things
	v	Class.	Classifying Animals	Students will use several senses not only to observe animals, but also to group them on the basis of similarities or differences in gross classification
1	*e	Obs.	Observing Temperature	Students will compare coded temperature ranges, associating a higher column in the thermometer with a warmer temperature
	s	Class.	Purpose of Classification	Students apply their classifying skills to explain the purpose of classification. They will classify objects according to weight, size, color, etc.

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
1	*b	S/T Rel.	Symmetry	Students will recognize symmetry or lack of symmetry in the physical and biological environment. Covers only line and plane symmetry
	*e	Obs.	Observation, Using Several Senses	Involves the use of several senses in making popcorn. Points out the specific functions of the senses
	*g	Obs.	Observing the Weather	Introduces reading the numerical scale of the thermometer to give greater precision of measurement and using comparative phrases in describing weather
	j	Meas.	Comparing Volumes	Examines the idea of relative volume and the ability to order volumes by inspection
	*o	Obs.	Observing Color and Color Changes in Plants	Extends the variety of color changes to include some of those which occur in plants which are cooked
2	l	Meas.	Linear Measurement Using Metric Units	Discusses the importance of having a standard unit(s) and introduces metric units of linear measurement
	*m	Obs.	Observing Some Properties of Magnets	Introduces the attractive property of magnetism based on observations of various metal objects with a variety of materials
	*n	Meas.	Making Comparisons Using a Balance	Introduces the equal-arm balance to provide precision in comparing weights of objects
	*p	Comm.	Introduction to Graphing	Introduces the simple bar graph as a way of picturing and relaying information
	v	Obs.	Observing Mold Gardens	Careful study of molds and mold changes utilizing the student's ability to observe color, size and shape
	y	Comm.	Describing Changes in Plants	Explores a common view of plants as being inactive and immobile. Arouses curiosity when changes are observed in sensitive plants such as the venus flytrap
	*z	Meas.	Seeds and Seed Germination	The concept of optimum condition is introduced. Explains that the potential for growth exists in seeds and given the proper environment, this potential may be stimulated and germination will occur

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
1	*b	Class.	Kinds of Living Things in Aquarium	Increases the variety of plants and animals for the students to study and introduces a detailed system of classification
2	*g	Comm.	Graphing Data	Exercises in this lesson provide additional experiences in drawing and interpreting bar graphs as a way to communicate information about a set of data
	*h	Pred.	Using Graphs	Dropping sand vials into a marked container filled with water enables students to follow the simple number progression, and then to predict the results of measurements not yet made. Results are graphed on paper
	*i	Inf.	Inferring Characteristics of Package Articles	Promotes careful reasoning about observations. Students will practice distinguishing between what they can observe with their senses and what they can infer from their observations
	e	Obs.	Observing Animal Responses to Stimuli	Activities center around the movements of animals that are familiar to students and are characteristic of several kinds of simple locomotion
3	f	Meas.	Measuring Forces with Springs	Students are asked to make a measurement of something they can feel but not see--a force. Though the force is not visible, students can see its results in the stretching of the spring
	j	Meas.	Estimations and Comparisons Using Metric System	Students are introduced to measuring objects which cannot be measured by direct comparisons. In such cases, estimation is used
	l	Comm.	Describing Growth from Parts of Plants	Students will work with, observe and report about plants that do not require seeds for reproduction
	*m	Class.	Solid, Liquid, and Gaseous States of Matter	Students should discover principles by which different kinds of matter are classified as solid, liquid or gas
	*p	Meas.	An Introduction to Scales	Helps students appreciate the usefulness of scaling in visualizing an object in its correct size
	*s	Meas.	Temperature and Thermometers	Students learn how to use a thermometer and read it in different scales. They also learn how to make a thermometer with their own arbitrary scale
	u	Meas.	Measuring Volumes	The standard metric units for measuring the volume of a liquid is introduced to the students
	*v	Class.	Separating Materials from Mixture	Students will try several ways of separating materials from solid mixtures and then measuring the separated solids with an equal-arm balance
	w	Pred.	Surveying Opinion	Students are provided with experiences in making predictions based on data recorded in a survey of classes in the school
	n	Inf.	Differentiating Between Similar Things	Teaches students to make as many observations as possible before making an inference. Emphasis is placed on the unreliability of quick inferences on materials that are similar in appearance

SAPA I - PART D

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
3	*a	Inf.	Observations and Inferences	With the use of cartoons, students will learn to differentiate between an observation and an inference
	*c	Pred.	Describing the Motion of a Bouncing Ball	Students will observe the bounce heights of different kinds of balls and use graphs to predict values between observed data by interpolation
4	*e	Inf.	The Displacement of Water by Air	Inferences are drawn after observing movement of water out of a container with the use of a straw
	g	Meas.	Measuring Drop by Drop	Students will learn that other things being equal, the size of a drop is different for different liquids and also that the inside diameter of the dropper tip affects the size of a drop
	k	Meas.	Measuring Evaporation of Water	The exercises here concern the evaporation of water from jars under different conditions and also, the drying of wet material, so that students will learn something about the process of evaporation and what affects it
	*m	Pred.	The Suffocating Candle	Students will observe a burning candle covered by a glass jar, then predict whether the burning time will be longer or shorter with different jars on the basis of measurement of both jar volume and burning time
	*n	Obs.	Magnetic Poles	Permanent magnets and electromagnets will be used to observe and compare their magnetic fields by the appearance of iron-filing patterns
	*q	Obs.	Observing Growth from Seeds	Students visualize growth patterns and some of the changes that occur from seed germination and the growth of roots, stems and leaves
	r	Comm.	Reporting an Investigation in Writing	Introduces students to reporting the procedures and the results of an investigation by the use of pebbles and sand to explore questions fundamental to the study of sedimentary rock deposits
	*t	Class.	Using Punch Cards to Record a Classification	Punch cards are used to classify the members of the class according to easily defined properties. It demonstrates the nature of an orderly and automated system of coding a classification scheme and the ease of recovering the information

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
5	*a	Inf.	Inferring Connection Patterns in Electric Circuits	Through the use of batteries and lamps, students make observations and inferences on electric circuits
	b	Con. Var.	Rolling Cylinders	Given an array of cylinders and spheres of different dimensions, weights, and materials, students roll 2 cylinders at a time down an incline plane to find out which of a number of variables might affect the time required to roll the length of the incline
	*c	Con. Var.	Upward Movement of Liquids in Materials	Students observe water moving up in blotting paper and make inferences that suggest what variables are important in influencing the rate of movement
	*d	Int. Data	Guinea Pigs in a Maze	Students collect and interpret data on the time required for 2 guinea pigs to go through a maze
	h	Form. Hyp.	Observations and Hypothesis	Students make simple observations to suggest a generalized statement and examine further observations to determine whether or not these observations support the hypothesis
	*i	Def. Op.	Electric Circuits and Their Parts	Students will learn to identify and use operatonal definitions by continuing the work with circuits they began in Exercise a (Part E)
	j	Form. Hyp.	Conductors and Nonconductors	Students conduct an investigation related to thermal and electrical conductors
	*k	Class.	Classifying Minerals	Students identify minerals through a classification system based on properties of hardness, luster, and color
	*l	Int. Data	Identifying Materials	Students are given 4 white powders that appear to be identical which they treat with 3 different liquids. They then observe the changes and record their observations in a table. This information is then used to identify the powders by comparing this information with observations made on changes that occurred when the powders were treated with the liquids again
	*m	Def. Op.	Analysis of Mixtures	Students use operational definitions to identify solutions or to separate mixtures of some common substances
	p	Con. Var.	Growth of Mold on Bread	Students identify and try to control factors in the environment that might influence mold growing on bread
	q	Con. Var.	Loss of Moisture from Potatoes	Students identify and control factors in the environment that might influence a section of fruit or a vegetable from which moisture is evaporating
	*v	Def. Op.	Living Things are Composed of Cells	Students are introduced to the use of the microscope and to communicate the observations they made with the microscope

GRADE	EXERCISE	PROCESS	TITLE	DESCRIPTION
6	a	Con. Var.	Variables Affecting Chemical Reactions	Stresses thecontrolling variables process in exercises designed for an inquiry into developing light-sensitive papers such as blueprint and ozalid papers
	b	Form. Hyp.	Effect of Temperature on Dissolving Time	Students will observe the effect of temperature on the rate at which a viscous liquid pours, on the rate at which sugar dissolves in water, and on the time required for seltzer tablets to dissolve in water
	c	Int. Data	Magnetic Fields	Principle focus is on the development in interpreting data. Students will collect data about compass directions and will use them to make inferences about magnetic fields
	g	Int. Data	Quantitative Analysis of Mixtures	This exercise is concerned with the quantitative analysis task of identifying and determining the quantities of the components of mixtures such as taconite and alundum. Many methods of separation are employed
	i	Form. Hyp.	Levers	Students will formulate and test hypotheses related to a simple lever system suspended at its center. The principle taught is the same principle as that of the see-saw or teeter-totter
	j	Con. Var.	Forgetting and Relearning	Investigates into the theory that learning consists of extending, consolidating, and reinforcing old capabilities. Students will hypothesize about learning and relearning as it relates to memorization
	r	Con. Var.	Small Water Animal	Students will have the opportunity to observe small animals (brine shrimp or guppies) and the responses they make to variations in their environment
	k	Form. Hyp.	Tasters and Nontasters	Permits students to identify some differences and likenesses in people and animals, to survey their classmates in regard to some human characteristics and to state and test hypotheses based on data they collect or on data given. The ability to taste PTC (phenylthiocarbamide) is mainly involved

A SUGGESTED SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS) SUPPLEMENTED K-6 FRAMEWORK

Compiled by:

Myrna Daguio	Ewa Beach Elementary
Clara Goto	Mililani Waena
Sylvia Kaizuka	Salt Lake Elementary
Lily Kido	Kunia Elementary
Sharon Lieberman	Waimanalo Elementary
Colleen Murakami	Maili Elementary
Jacquelin Yoshimoto	Makaha Elementary

Grade 1:

Objective: To help the child sharpen powers of observation, discrimination and accurate description with living and non-living objects.

Learning Areas: (Major Concepts)

Physical Science: Material Objects

- object
- property
- material
- serial ordering
- change
- evidence

Life Science: Organisms

- organism
- birth
- death
- habitat
- food web
- detritus

Basic Science Program: Science Curriculum Improvement Study

These are some of the available local activities and resources that can be used as a supplement to the study of Organisms in Grade 1.

Hawaii Nature Study
By: Sister Edna L. Demanche, Ph.D.

Plants

1.	2A Kinds of Stems Band 1	pgs. 8-9
2.	4A Looking at Leaves Band 1	pg. 36
	a. "Problems" on Leaves	pgs. 36-37
3.	Roots Band 1	pg. 59
4.	7A Flowers Band 1	pgs. 68-70
5.	9A Vegetables Band 1	pgs. 100-101
6.	10A Structure of Seeds Band 1	
	What is a seed	pg. 110

Insects

1.	Cockroach Investigation Life Cycle Band 1 (Emphasis on Birth and Death)	pg. 67
2.	Life Cycle of Mosquitoes Band 1 (Mosquitoes might be found in the green water--a unit could be introduced and incorporated into the food web since guppies eat wigglers as with the daphnia.)	pg. 60

Grade 1 (continued)

Reef and Shore

1. Tide pool visits to observe plant and animal life
2. Plant life available Band 1 — pg. 211
3. Characteristic of properties of Seaweed Band 1 — pgs. 222-223
4. Seaweed Recipe

Outdoor Education Studies K-12
An Approach to Environmental Education
Central Oahu District DOE TAC 76-2003
August 1976

Botanical Studies

1. Observe plants at Foster Garden — pg. 89
2. Paradise Park — pg. 112
3. Wahiawa Botanical Gardens — pg. 114

Marine Studies

1. Aquarium — pg. 135
2. Sea Life Park — pg. 168
3. Kewalo Basin Glassbottom Boat — pg. 146

Other Ecological Studies

1. Zoo — pg. 201

Grade 2

Objective: To have the child observe change in both physical and life sciences.

Learning Areas:

Physical Science: Interaction and Systems

- observing change while doing simple experiments using a wide variety of materials
- interpreting change as evidence of interaction and writing simple reports on experiments conducted

Physical Science: Major Concepts

- interaction
- evidence of interaction
- system
- interaction-at-a-distance

Life Science: Life Cycles

- observing change in the growth and development of various plants; fruit flies, mealworms and other organisms as they go through their life cycles

Life Science: Major Concepts

growth	generation
development	plant and animal
life cycle	metamorphosis
genetic identity	

Basic Science Program: Science Curriculum Improvement Study (SCIS)

Supplementary Resources:

Frogs - Chapter 7. If frog eggs are not available, gather tadpoles from local streams - Manoa, Moanalua, etc.

Hawaii Nature Study Program (available in library)

Parts of Plants

9B Vegetables Band 2	pg. 102
Kinds of fruits in neighborhood	pgs. 82-83
8-A Fruits Band 1	

Insects

Life Cycle of Butterfly Band 1	pgs. 43-44
Butterfly Tree	pg. 44
Miscellaneous Insects	pgs. 80-84
Metamorphosis	pgs. 90-92
Cockroaches	pgs. 65-67

Grade 3

Objective: To have the child observe the feeding relationships among populations of organisms.

Life Science Unit: "Populations"

- observing interaction of various organisms within a community of plants and animals
- considering interdependence of individual and populations within the community

Major Concepts:

- population
- predator-prey
- plant eater
- animal eater
- food chain
- food web
- community

Supplement:

Tide Pool Biota (K-6), Shuichi Tanaka, Hawaii District Office, Department of Education. 1972

1.	Characteristics of tide pool	pg. 5
2.	Tide pool fishes	pg. 6
3.	Planning for a field trip	pgs. 9-10
4.	Supplies and equipment for field trip to tide pools	pg. 11
5.	Collecting, mounting and pressing seaweed	pgs. 20-23
6.	Sand	pgs. 24-26
7.	Tidal pool animals	pgs. 43-49
8.	Marine aquarium (Includes slides of tide pools and specimens)	pgs. 51-54

Hawaii Nature Study Program, Sister Edna L. Demanche, Hawaii, 1975

1.	Parts of Plants - measuring tree trunks (ancient standards of measure: anana, muku, iwilei p. 3)	pgs. 1-6
2.	Stems - size and kinds, inside pgs. 15-19	pgs. 8-9
3.	Bud to seed	pgs. 63-66
4.	Seeds - structure, distribution, feature	pgs. 109-119
5.	Insects - insect safari	pgs. 5-7
6.	Flower pot cages	pg. 18
7.	Food, water, care	pgs. 23-28
8.	Crickets	pgs. 33-37
9.	Aphids	pg. 83
10.	Reef and Shore	pg. 2
11.	Field trip	pgs. 6-12

12. Look boxes
13. Tide pools pgs. 58-70
14. Field observations (interacting populations) pgs. 118-122
15. Seaweed pgs. 211-223
16. Differences between salt water and fresh water
17. Buoyancy in sea water and tap water pgs. 230-231

Outdoor Education Studies K-12, Ron Kubota and Pearl Groves, Hawaii, 1976

1. Foster Botanical Gardens pgs. 89-94
2. Manoa Falls and Ala Wai Canal pgs. 95-111
3. Glass Bottom Boat Ride pgs. 146-148
4. Maili Point (Reef Walk) pgs. 149-167

Notes:

Chapter 1 - Tide pools would be one unit to take up as you study salt water and brine shrimp. Contact Maxine Ishiyama, Iliahi Elementary, grade 6, or Yvonne Toma, Kipapa Elementary, grade 2, since they have both done a lot of work in this area.

Chapter 2 - Planting peas: Check first to see if pea aphids would be available before planting peas. Petland has not been able to supply aphids so far. Is there a possible substitute for aphids?

Grade 4

Objective: To have the child develop scientific attitudes and investigative skills while gaining knowledge in both physical and life science.

Learning Areas:

Physical Science Unit: Relative Position and Motion

- techniques for dealing with spatial relationships of stationary and moving objects

Physical Science: Major Concepts

- reference object
- relative position
- rectangular coordinates
- reference frame
- polar coordinates

Life Science Unit: Environment

- investigations into some of the physical conditions that shape an organism's environment
- development of measurement skills
- recording and interpreting data using various charts

Life Science: Major Concepts

- environment
- environmental factor
- range
- optimum range

Supplementary for SCIS Life Science Program for Grade 4:

ESS Units:

Brine Shrimp

- involving salinity of water, degree of light, temperature, crowdedness

Earthworms

- environment investigations: light, temperature, wetness pgs. 19-23

Modular Activities Program in Science Activity and Record Book (Yellow), by Carl F. Berger, etc., Hughton Mifflin Co., Boston, 1974:

Kind of habitat and habitat factor hunt pgs. 74-88

Hawaii Nature Study Program--Insects

1. Crickets -- Temperature preferences of crickets pgs. 35-36
2. Mosquitoes -- Sensitivity of wigglers to movement, dependence on surface air pgs. 60-61
3. Cockroaches -- Preference of roaches for darkness or thigmotatic surface pgs. 67-68

Grade 4 (continued)

Hawaii Nature Study Program--Reef and Shore

1.	Hermit Crabs -- Where hermit crabs live	pgs. 45-46
2.	Tide Pools - Physical features of tide pool, measurement, life in the pools, distribution of plants and animals	pgs. 60-67
3.	Tide Pool in the Classroom -- Compare differences of light, temperature, etc.	pgs. 68-70
4.	Brittle Stars, Sea Urchins, Sea Cucumbers--Where to find them	pgs. 114, 119, 124-125
5.	Nerites and Periwinkles -- Where to find them	pg. 130
6.	Aplysias--Sea Hare--Reaction to light, heat, odor, etc., environmental tolerance	pgs. 165-166
7.	Coral -- Discover places around island where corals may not live because of temperature, light, salinity	pgs. 200-201
8.	Shoreline Land Plants -- Plants adapted to living near the beach	pgs. 205-210
9.	Seaweeds - Distribution	pgs. 211-212

100 Invitations to Investigate, (Kit) by Paul F. Brandwein and Hy Ruchlis, Concepts in Science, Harcourt, Brace and World, Inc., 1966

1. #3 "The Speed of Germination of Seeds" -- Conditions of seed germination
2. #32 "Population of Fish in a Jar" -- Is population determined by space available?
3. #38 "Effect of Salt Concentration on Plant Growth" -- Concentrations of salty soil
4. #63 "Relationship of Heredity and Environment" -- Vary environment (light, soil, water, etc.)

Tide Pool Biota, by Shuichi Tanaka, Hawaii District Office, Department of Education, Hawaii, 1972:

"Preparing a Marine Aquarium", "Comparing the interaction of the biological and physical elements in a tide pool and in the aquarium." Description of common tide pool animals and where to find them in the pool. pgs. 51-71

Films: Office of Library Services 16mm Film Catalog, 1976

5311		"Animal Aaptations in the Northern Environment" (12 min.)
0096		"Animal Habitats" (11 min.)
0098	MK	"Animal Life at Low Tide" (11 min.)
5637		"Animal Navigation" (15 min.)
3466		"Animals of the Desert" (12 min.)
3819	HMK	"The Desert Community" (12 min.)
0932		"Fish, Moon, and Tide -- The Grunion Story" (15 min.)

Grade 4 (continued)

1042		"Garden Plants and How They Grow -- Exploring Science" (11 min.)
1645	HK	"Life Between the Tides" (11 min.)
5428		"Life Under the Sea" (16 min.)
3439		"Oasis of the Sahara" (8 min.)
4299		"Plant-Animal Communities--Ecological Succession" (14 min.)
2291	H	"Plant Life at Work" (11 min.)
2296		"Plants of the Desert" (14 min.)
6471		"Survival and the Senses" (25 min.)
4406		"Why Plants Grow Where They Do?" (11 min.)
4810		"Your Environment Is the Earth" (14 min.)

Field Trips

1. Honolulu Zoo, Kapiolani Park -- Observe simulated habitats of various animals and adaptations.
2. Marine Science Education -- "Featuring Kuliouou Beach Park and Paiko Lagoon or Highlights of a Muddy Seashore" by Edward Arrigoni -- Description of muddy seashore life. May be used as a comparison with a rocky shore or sandy beach area.
3. Moanalua Valley Hike -- 4 miles one way, educational packet from Moanalua Gardens Foundations, Inc., 1352 Pineapple Place, Honolulu, Hawaii 96819:
   - Plant Survey -- number and distribution of a particular species of plant as one proceeds up or down the valley.
   - "The Origin of Moanalua Valley" by David Boynton -- discusses vegetation, zonation and adaptation.
4. Outdoor Education Studies K-12 -- An Approach to Environmental Education, Central District, 1976:

a. Maili Point -- Tide Pool	pgs. 149-167
b. Wailupe Mud Flats -- Tide Pool	pgs. 179-182
c. Sea Life Park and Aquarium--Marine Animals in Simulated Hawaiian Reef	pgs. 135-138, 168-178
d. Aiea Loop Trail -- Plants in natural habitat	pgs. 81-88

Grade 5 A

Objective: To have the child develop scientific attitudes and more complex investigative skills while gaining knowledge in both physical and life sciences.

Learning Areas:

Physical Science: Energy Source

- introduction of energy transfer concept
- application of system concept
- identification of variable
- interpretation of data

Physical Science: Major Concepts

- energy transfer
- energy chain
- energy source
- energy receiver

Life Science: Communities

- introduction of food transfer concept
- application of system concept
- identification of variables
- interpretation of data

Life Science: Major Concepts

- producer-community
- consumer
- decomposer
- photosynthesis

Supplementary Activities: Physical Science

1. Classroom ice cream
2. Elementary School Science (ESS) - Ice Cubes
3. Energy Activity with Energy Ant (pamphlet)
4. Energy Conservation - Understanding and Activities for Young People (pamphlet)
5. Environmental Studies (ES)
6. How and Why Wonder Book - Atomic Energy
7. Modular Activity Program in Science - green book pgs. 55-63
8. Outdoor Biology Instructional Strategies (OBIS)
9. Science - A Process Approach (SAPA I & II)
10. Science Guide for the Elementary School of Hawaii pgs. 107-109
11. Unified Science and Mathematics for the Elementary School (USMES)
12. The Wonderful World of Science pgs. 22-23 (ETV)

Field Trips:

1. Board of Water Supply
2. Ka'ena Point (tracking station)
3. Hawaiian Electric Company
4. Standard Oil Company
5. University of Hawaii -- Solar Energy

Grade 5 B

Objective: To have the child develop scientific attitudes and more complex investigative skills while gaining knowledge in physical and life sciences.

Learning Areas:

Life Science: Communities

- introduction of food transfer concept
- application of systems concepts
- identification of variables
- interpretation of data

Life Science: Major Concepts

- producers
- consumers
- decomposers
- photosynthesis
- community

Supplementary Activities on Plants: Producers

Hawaii Nature Study Program: Parts of Plants by Curriculum Research and Development, University of Hawaii

- Structure of the Seed (Remediation Lesson) pg. 110
- Seed Distribution " pg. 111
- External Features of a Seed " pg. 115
- Internal Features of a Seed " pg. 118

Science Activities for Elementary Children, 5th Edition, 1972, by Leslie Nelson and George Lorbeer

- Experiments with Germination pgs. 116-119
- Experiments with Plant Growth pgs. 120-126

Enriching Elementary Science with Games and Activities by Guy Wagner, Joan Duea, D. Louis Finsand, Dorlan Mork; 1967

- Bean Race (Experiment to find the best conditions to grow a plant) pg. 82

OBIS Trial Edition, Set I (Outdoor Biology Instructional Strategies)

- Invent a Plant - Adaptation
- Plants Around a Building

OBIS Trial Edition, Set II

- Plant Pattern (Environmental factors affecting plant distribution)

Supplementary Activities on Animals: Consumers

Hawaii Nature Study Program: Insects by Curriculum Research and Development Group, University of Hawaii

- Reproduction of Crickets pgs. 33-37
- Insects Songs - How Do Crickets "Sing"? pgs. 38-39

Grade 5B (continued)

OBIS Trial Edition, Set I

- invent an animal - adaptation
- adaptation - predator - prey

OBIS Trial Edition, Set II

- Food Chain Game - Survive as an animal by getting enough to eat while avoiding being eaten yourself.

Supplementary Activities on Decomposers

Enriching Elementary Science with Games and Activities, by Guy Wagner, Joan Duea, D. Louis Finsand, Dorlan Mork

- Mold Race (Who can grow the most mold) pg. 95

Supplementary Activity on Community

OBIS Trial Edition, Set I

- Out of Control - Release a portion of your lawn from man's control. Observe the resulting changes in the lawn community.

Hawaii Nature Study Program: Reef and Shore

- Study a tidepool community

ES (Environmental Studies) or Essence Cards by Addison Wesley Co.

- Live Change - Go outside and prove that some living things in your environment change

Possible Field Trips:

1. University of Hawaii Waimanalo Experimental Farm (for plants)
2. Foster Botanical Garden
3. Waiahole Valley - Visit the farms
4. Potato Farm
5. Tap Pryor's Aquaculture Farm in Kahuku
6. University of Hawaii Wailee Experimental Farm (for animals)
7. Honolulu Zoo
8. Aquarium

Grade 6 A

Objectives: To have the child develop scientific attitudes and increasingly complex investigative skills while gaining knowledge in both physical and life sciences.

Learning Areas:

Physical Science - Models: Electric and Magnetic Interaction

- introduction of scientific model concept
- using scientific models in new levels of data interpretation and hypothesis making
- relating matter and energy to electrical phenomena

Physical Science: Major Concepts

- scientific model
- electricity
- magnetic field

Life Science: Ecosystem

- integration of all preceding physical and life sciences units in investigating exchange of matter and energy, between organisms and their environment

Life Science: Major Concepts

- ecosystem
- water cycle
- oxygen and carbon dioxide cycles
- pollution

Supplement Activities: Physical Science

Magnets	Electricity
1. ESS	Batteries and Bulbs I and II
2. First Book Series - Science	Electricity
3. How and Why Wonder Books Magnets and Magnetism	Electricity
4. Modular Activity Program in Science	Green Book (Structure System, Motion and Change; Conduction System; Interaction in a Population; pgs. 63-64 Purple Book (Invisible System, Models, Population Needs, Ecological Integration; pgs. 86-87
5. SAPA Level 3 - Static and Moving Objects; Magnetic Poles Level 5 - Earth's Magnetism	Level 4 - Circuits and Boards; Cells, Lamps, Switches; Conductors and Nonconductors

Grade 6 A(continued)

Supplement Activities (continued)

Magnets	Electricity
6. Science Guide for the Elementary School's of Hawaii Magnets, pgs. 115-129	
7. The Wonderful World of Science (ETV) Magnets, pgs. 35-42	
8. USMES	Electricity Burglar Alarm Design Electromagnetic Device Design

Grade 6 B

Objective: To have the child develop scientific attitudes and incresingly complex investigative skills while gaining knowledge in both physical and life sciences.

Learning Areas:

Physical Science: Models--Electric and Magnetic Interactions

- introduction of scientific model concept
- using scientific models in new levels of data interpretation and hypothesis making
- relating matter and energy to electrical phenomena

Physical Science: Major Concepts

- scientific model
- electricity
- magnetic field

Life Science: Ecosystems

- integration of all preceding physical and life science units in investigating exchange of matter and energy between organisms and their environment

Life Science: Major Concepts

- ecosystem
- water cycle
- oxygen and carbon-dioxide cycles
- pollution

Supplementary Materials for Life Science Unit

Outdoor Education Studies K-12; An Approach to Environmental Education - Central District

1.	Kaena Point - nature's beauty vs. man-made pollutions	pg. 10
2.	Camp Hanauma Bay - investigations of the marine biota; ecosystem (use as teacher reference only - high school level)	pgs. 30-41
3.	Keaiwa Heiau State Park (Aiea Loop Trial) - keeping an ecological balance in nature; interdependence of all living things	pgs. 81-88
4.	Manoa Falls and Stream; Ala Wai Canal - ecology (use as teacher reference)	pgs. 95-111
5.	Honolulu Harbor - water pollution	pgs. 139-145
6.	Paper Stock of Hawaii Inc. - problem of solid waste	pgs. 223-229
7.	Print References - available through Central District	pgs. 242-246

Grade 6 B (continued)

Hawaii Nature Study; for Elementary School Children - Reef and Shore, Sister Edna L. Demanche

- discussion of ecological data: comparisons — pgs. 66-67
- food chain — pg. 255

Waikiki Aquarium field trip curriculum materials; "Marine Communities for Grades 6 and 7"

1. Tidepool Communities (pre-visit activity) — pg. 4
   a. Activity 3 - to observe a form of pollution and its effects (post-visit activity) — pg. 4
   b. Activity 1 - Review what was learned about tidepools
2. Sandy, Rocky, and Coral Communities (post-visit activity) — pg. 5
   a. Activity 2 - to think of the possible results of pollution by heavy sedimentation on a coral community

Featuring Kuliouou Beach Park and Paiko Lagoon or the Highlights of a Muddy Seashore, by Edward Arrigoni

- Marine Science Education - field trip — pgs. 4-8
- II. Lessons in Ecology

Pollution: Examining Your Environment - (booklet), Holt, Rinehart and Winston of Canada. Limited, copyright 1971 (Momilani Elementary)

Modular Activities Program in Science - Activity and Record Book, Houghton Mifflin Company, copyright 1974

1. "Structural Systems; Motion and Change; Conduction Systems; Interaction in a Population" - lime green booklet
   a. Completing the water cycle — pg. 35
   b. Ant colony record — pg. 69
   c. Collection notes on plant feeders — pg. 73
   d. Classroom predator-prey report — pg. 75
   e. Food chain report — pg. 80
   f. Food web game — pg. 81
   g. Country farm food web — pg. 82
   h. Classroom communigram — pg. 83
   i. School yard communigram — pg. 84
   j. Environments change — pg. 86
   k. Interaction results — pg. 87
2. "Invisible Systems; Models; Population Needs, Ecological Interactions" - purple booklet (looks good!)
   a. Operation final cleanup — pg. 33
   b. An ecosystem hunt — pg. 67
   c. The square-meter ecosystem — pg. 70
   d. Producers and consumers in ecosystems — pg. 71

e. Pollutants produced by man — pg. 75
f. What materials will decompose? — pg. 76
g. Record of brine shrimp and heat — pg. 83
h. Brine shrimp and crowding — pg. 85

Science Through Discovery 6 - (textbook), L.W. Singer Company; A Division of Random House, Inc., copyright 1968. (same copy at Kunia)

1. Unit 6 -- Air Pollution — pgs. 234-263
2. Unit 7 -- Ecology — pgs. 264-303

(Good reading reference for sixth graders doing written research, etc. ... some activities)

Reading References for Students - Kaimuki Library

1. Discovering Cycles - Glenn O. Blough - J 574 B

a. Water cycle — pgs. 20-25
b. Cycles in an aquarium — pgs. 41-45

2. Ecology - Jeanne Bendick - J 574.5 B

- Simple, light reading, interesting questions

3. Ecology: The Circle of Life - Harold R. Hungerford - J 574.5 H

- Heavy reading for average sixth graders

4. Understanding Ecology - Elizabeth T. Billington - J 574.5 B

- Heavy reading for average sixth graders

5. A Guide to Nature Projects - Ted S. Pettit - J 574 P

a. Interesting — pgs. 12-38, 83-107

10. D.O.E. Films

5635 Aging of Lakes: Environment in Crisis E-H; 14 min.
3484 Animal Predators and the Balance of Nature E-J; 10 min.
5339 Cave Ecology E-H; 13 min.
0391 Chain of Life E-J; 11 min.
0401 The Changing Forest E; 19 min.
5669 Child's Garden of Pollution E-H; 12 min.
4163 Desert Insects - A Story of Survival E-H; 13 min.
5760 Ecology: Checks and Balances E-J; 14 min.
5387 Grasslands Ecology - Habitats and Change E-H; 13 min.
5728 Great Barrier Reef - Parts I and II E-H; 53 min.
6314 Is This Our Father's World E-HC; 9 min.
1641 Life Along the Waterways E-J; 11 min.
3883 Life in a Vacant Lot E; 10 min.
1675 Life in the Grasslands - North America E-H; 11 min.

Grade 6 B (continued)

1816 Man Makes a Desert E-J; 11 min.
6278 Once There Were Bluebirds E; 5 min.
2193 Partnerships Among Plants and Animals E-J; 11 min.
4299 Plant-Animal Communities - Ecological Succession E-J; 14 min.
5522 What Ecologists Do E-H; 16 min.
5306 Ah Man, See What You've Done! E-HA; 23 min.
1614 Let's Keep America Beautiful E-HA; 20 min.
5431 H The Litter Monster P-J; 17 min.
1729 H Litterbug E; 10 min.
5089 H Men at Bay E-H; 26 min.

Clean Hawaii - 677 Ala Moana Boulevard, Suite 603, Honolulu, Hawaii 96813; Phone: 537-3902

- Package that includes a lesson plan outline (K-12), suggested projects, an audio-visual list and resource pamphlet.

NOTE:

Additional activities and materials can be found in the ESS and USMES program to supplement the SCIS program.

APPENDIX

- performance expectations
- guidelines for selecting a program
- helpful hints and other ideas
- a student guide for projects--science fair and otherwise
- science laboratory safety and practices
- resource materials
- glossary
- teacher suggestion forms

APPENDIX

The appendix serves as a "helpful hints and ideas" section. It is intended to include not only suggestions for evaluation of oneself but also as a means of sharing ideas and activities suggested by your colleagues.

This section should become very personal as you add ideas and activities that work for you and your students at your school.

If you don't mind sharing these with other elementary science teachers, use the teacher suggestion forms provided at the end of this Appendix and we will publish and disseminate your contributions.

PERFORMANCE EXPECTATIONS

WHAT ARE PERFORMANCE EXPECTATIONS

The purpose of performance expectations is to provide teachers and administrators with statements of desired student behavioral outcomes resulting from instruction. To achieve these outcomes, planned educational experiences are to be directed towards contributing to each student's full development throughout the years of public schooling in Hawaii.

The eight Foundation Program Objectives established by the Department of Education serve as the basis for curriculum and instruction in the public schools. These eight objectives are:

1. Develop basic skills for learning and effective communication with others.

2. Develop positive self-concept.

3. Develop decision-making and problem-solving skills.

4. Develop independence in learning.

5. Develop physical and emotional health.

6. Recognize and pursue career development as an integral part of personal growth and development.

7. Develop a continually growing philosophy that reflects responsibility to self as well as to others.

8. Develop creative potential and aesthetic sensitivity.

Because of the general way in which these objectives are stated, relating them directly to classroom instruction is difficult. Performance expectations are written to specify important competencies expected of students as they progress toward the attainment of the eight Foundation Program Objectives.

Performance expectations are very important statements of desired student behavior. Each performance expectation specifies a behavior which requires the application of knowledge, skills or attitudes. For each Foundation Program Objective, performance expectations collectively serve to describe the breadth and depth of a student's desired achievements and progress. Although individual student levels of achievement will vary, the Department is obligated to take each student to his or her highest level.

Student performance expectations were developed for grades 3, 6, 8, 10 and 12. These grades represent critical points in major stages of human development such as early childhood, preadolescence, adolescence and adulthood. Performance expectations identified for these grades reflect development through the preceding years and including the specified year. That is, the expectations of students at the end of the third grade are based on sequential development from kindergarten through grade 3. Likewise, the attainment of performance expectations of subsequent grades is

dependent on the cumulative effects of instruction. Therefore, teachers at all grades should use the performance expectations as a guide to provide for individual differences and instruction.

The mission of the Department is "to provide educational services and opportunities for the development of all students in Hawaii to their maximum potential--mentally, physically, and socially--so that they will be contributing members of our society."

In support of this mission, all teachers are expected to use the eight Foundation Program Objectives in planning and developing instructional programs for their students. Instructional planning for meeting the Foundation Program Objectives will be promoted through the use of performance expectations. Performance expectations provide the basis for:

1. relating instructional areas to the Foundation Program Objectives;

2. developing instructional objectives;

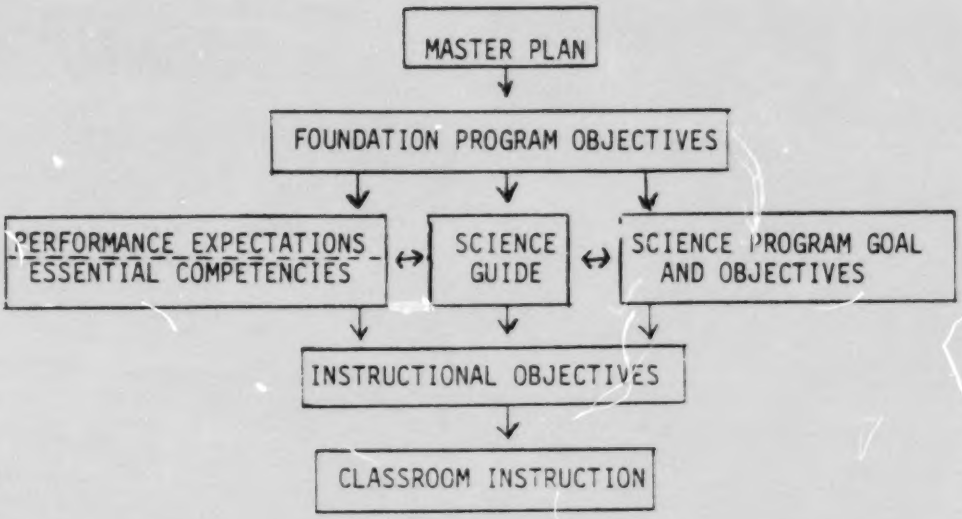
3. measuring student progress and adjusting classroom instruction;

4. securing related assessment information such as student background, interests, work habits and learning styles; and

5. insuring appropriate and timely instruction for each student.

Effective instructional planning and, more specifically, use of performance expectations will result from two important understandings. First, instructional planning and use of performance expectations must be based on the concept that meaningful instruction is learner-centered, where each student is viewed as an individual. Therefore, the performance expectations are not intended to prescribe the scope and sequence of learning for all students. Over the span of years, each student's learning sequence and achievement will differ within and among the Foundation Program Objectives. From assessment data, the individual's strengths may be identified and used for planning success-oriented activities to improve areas of weaknesses.

Second, use of performance expectations requires clear understanding of the relationship among Foundation Program Objectives, instructional area objectives, performance expectations, essential competencies, science guide, instructional objectives, and classroom instruction. (See Figure 1)



RELATIONSHIP AMONG SCIENCE GUIDE, MASTER PLAN, FOUNDATION PROGRAM OBJECTIVES, PERFORMANCE EXPECTATIONS, ESSENTIAL COMPETENCIES, SCIENCE PROGRAM GOAL AND OBJECTIVES, INSTRUCTIONAL OBJECTIVES AND CLASSROOM INSTRUCTION. (Figure 1)

Seeing the relationship of student performance expectations to the other important elements that direct instruction for the student, as diagrammed above, is essential if the teacher is to promote the optimum development of each student. This relationship, integrated with an understanding of the learner's needs, styles of learning, and expectations will provide teachers with the bases for developing meaningful and relevant science instructional objectives and classroom instruction.

---

[1]Student Performance Expectations of the Foundation Program. Department of Education, April 1978.

SCIENCE PERFORMANCE EXPECTATIONS FOR GRADES 3, 6, 8, 10, and 12

SCIENCE

Grade 3

- Answers questions related to directed science activities
- Acquires information that emerges from simple given scientific experiments
- Solves simple problems that require manipulation of objects and ideas
- Asks appropriate questions to gather information needed to explain natural phenomena
- Records and reports simple quantitative experimental data
- Infers possible causes of an observed or represented effect
- Uses simple scientific measuring tools and equipment to solve problems
- Cites examples of cause and effect relationships in nature
- Defines a simple scientific problem or question to be investigated
- Uses experimental information to recognize some simple quantitative and qualitative change patterns in observed phenomenon
- Checks out reliability of information derived from a simple given scientific experiment

- Completes work in science with supervision
- Shows curiosity about natural phenomena
- Identifies at least one way for finding answers to questions and for solving problems in science
- Asks questions to gather information needed to explain natural phenomena
- Uses a variety of sources to acquire information including information on file
- Summarizes retrieved information according to set purpose

- Follows health and safety precautions and rules while participating in science activities
- Identifies reasons for the necessity of health and safety precautions and rules while participating in science activities
- Identifies and describes health and safety practices to be followed and respected in conducting science activities

- Exhibits awareness of science as relevant to all persons
- Uses scientific knowledge and skills in every day situations
- Recognizes contributions of science and technology in shaping our world

- Demonstrates interest in science by participating in teacher-directed activities
- Works in group situations dealing with science activities
- Completes teacher-directed science assignments
- Demonstrates openness to others point of view by revising science judgments when concrete data justifies this
- Works independently to pursue science assignments
- Works on group experiments taking responsibility for a share of the work

Grade 6

- Solves simple problems that require manipulation of objects and ideas
- Asks appropriate questions to gather information needed to explain natural phenomena
- Uses a variety of sources to acquire information including information on file
- Records and reports simple quantitative and qualitative experimental data
- Infers possible causes of an observed or represented effect
- Uses simple scientific measuring tools and equipment to solve problems
- Cites examples of cause and effect relationship in nature
- Defines a simple scientific problem or question to be investigated
- Uses drawings, graphs and charts to analyze and communicate experimental information
- Uses experimental information to recognize some simple quantitative and qualitative change patterns in observed phenomenon
- Checks out reliability of information derived from a simple given scientific experiment
- Identifies actions and outcomes of a controlled experimental situation
- Analyzes experimental information and draws simple interpretations
- Uses interpretations of data to check out generalizability of experimental findings or to formulate generalizations
- Applies generalizations to appropriate interpretations of information

- Identifies at least one method for finding answers to questions and for solving problems in science
- Asks questions to gather information needed to explain natural phenomena
- Uses a variety of sources to acquire information including information on file
- Summarizes retrieved information according to set purpose
- Studies science-oriented materials independently and applies knowledge learned to solve scientific problems
- Conducts simple scientific experiments to explore given problems

- Identifies reasons for the necessity of health and safety precautions and rules while participating in science activities
- Identifies and describes health and safety practices to be followed and respected in conducting science activities
- Uses preventive approaches to health and safety practices while conducting science activities

- Uses scientific knowledge and skills in everyday situations
- Recognizes contributions of science and technology in shaping our world
- Demonstrates knowledge that scientific discoveries and technology affect the entire world of work
- Identifies various science-related vocations or professions

- Completes teacher-directed science assignments
- Demonstrates openness to others point of view by revising science judgments when concrete data justifies this
- Works independently to pursue science assignments
- Works on group experiments taking responsibility for a share of the work
- Describes benefits of working alone or with others to solve scientific problems
- Shows understanding of the importance of his/her work and the work of others in science

Grade 9

- Cites examples of cause and effect relationships in nature
- Defines a simple scientific problem or question to be investigated
- Uses drawings, graphs and charts to analyze and communicate experimental information
- Uses experimental information to recognize some simple quantitative and qualitative change patterns in observed phenomenon
- Checks out reliability of information derived from a simple given scientific experiment
- Identifies actions and outcomes of a controlled experimental situation
- Analyzes experimental information and draws simple interpretations
- Uses interpretations of data to check out generalizability of experimental findings or to formulate generalizations
- Applies generalizations to appropriate interpretation of information
- Identifies tentative generalizations as hypotheses to be tested
- Evaluates experimental information according to specified criteria
- Interprets cause and effect relationships within a scientific problem-solving situation
- Selects and uses appropriate tools for obtaining experimental measurements

- Uses a variety of sources to acquire information including information on file
- Summarizes retrieved information according to set purpose
- Conducts simple scientific experiments to explore given problems
- Studies science-oriented materials independently and applies knowledge learned to solving scientific problems
- Demonstrates personal strategies for experimenting and problem-solving in the performance of laboratory investigations
- Seeks scientific knowledge and communicates that knowledge to others
- Detects biases and how they distort data, conclusions or assertions
- Designs experiment to explore given scientific problem

- Identifies and describes health and safety practices to be followed and respected in conducting science activities
- Uses preventive approaches to health and safety practices while conducting science activities
- Describes actions to be taken in the event of accidents while conducting science activities

- Recognizes contributions of science and technology in shaping our world
- Demonstrates knowledge that scientific discoveries and technology affect the entire world of work
- Identifies various science-related vocations or professions
- Demonstrates knowledge about the work of professional, para-professional and non-professional scientific personnel

- Works independently to pursue science assignments
- Works on group experiments taking responsibility for a share of the work

- Demonstrates his/her familiarity with scientific procedures by setting realistic goals and assuming responsibility for pursuing them
- Evaluates his/her work and the work of others in science realistically

SCIENCE (continued)

Grade 10	Grade 12
• Identifies actions and outcomes of a controlled experimental situation. • Analyzes experimental information and draws simple interpretations. • Uses interpretations of data to check out generalizations. • Applies generalizations to appropriate interpretation of information. • Uses drawings, graphs and charts to analyze and communicate experimental information. • Identifies tentative generalizations as hypotheses to be tested. • Analyzes experimental information according to specified criteria. • Interprets cause and effect relationships within a scientific problem-solving situation. • Selects and uses appropriate tools for obtaining experimental measurements. • Uses language associated with instruments and operations in scientific experiments. • Predicts consequences of alternative decisions and actions in a problem-solving situation. • Reports a scientific research using appropriate methodology and format. • Selects and uses scientific principles to determine acceptability of experimental findings.	• Identifies tentative generalizations as hypotheses to be tested. • Analyzes experimental information according to specified criteria. • Interprets cause and effect relationships within a scientific problem-solving situation. • Selects and uses appropriate tools for obtaining experimental measurements. • Uses language associated with instruments and operations in scientific experiments. • Predicts consequences of alternative decisions and actions in a problem-solving situation. • Reports a scientific research using appropriate methodology and format. • Uses accurate terms to present analytical systems, models, or procedures. • Uses appropriate statistical procedures in summarizing and analyzing data. • Prepares independent research paper on a scientific problem for public sharing.
• Conducts simple scientific experiments to explore given problems. • Studies science-oriented materials independently and applies knowledge learned to solving scientific problems. • Demonstrates personal strategies for experimenting and problem-solving in the performance of laboratory investigations. • Seeks scientific knowledge and communicates that knowledge to others. • Detects biases and how they distort data, conclusions or assertions. • Designs experiment to explore given scientific problem. • Evaluates the adequacy of experimental data as a basis for drawing tentative conclusions. • Identifies and considers a variety of alternatives when solving problems or making decisions. • Recognizes consequences of decisions and actions.	• Demonstrates personal strategies for experimenting and problem-solving in the performance of laboratory investigations. • Seeks scientific knowledge and communicates that knowledge to others. • Detects biases and how they distort data, conclusions or assertions. • Designs experiment to explore given scientific problem. • Evaluates the adequacy of experimental data as a basis for drawing tentative conclusions. • Identifies and considers variety of alternatives when solving problems or making decisions. • Recognizes consequences of decisions and actions. • Predicts and weighs consequences of alternative decisions and actions. • Reanalyzes data and provides further evidence in support of findings when confronted with conflicting data. • Seeks opportunities to study a scientific problem in depth. • Demonstrates knowledge of research methodology in carrying out independent scientific investigations.
• Uses preventive approaches to health and safety practices while conducting science activities. • Describes actions to be taken in the event of accidents while conducting science activities. • Demonstrates sound laboratory procedures and practices while conducting scientific experiments.	• Describes actions to be taken in the event of accidents while conducting science activities. • Demonstrates sound laboratory procedures and practices while conducting scientific experiments. • Includes health and safety considerations in the design of independent research studies in science.
• Demonstrates knowledge that scientific discoveries and technology affect the entire world of work. • Demonstrates knowledge about the work of professional, para-professional and non-professional scientific personnel. • Displays knowledge that the various sciences and areas of study are interrelated. • Uses scientific knowledge, conventions, and skills to clarify values and attitudes in exploring career options.	• Demonstrates knowledge about the work of professional, para-professional and non-professional scientific personnel. • Displays knowledge that the various sciences and areas of study are interrelated. • Uses scientific knowledge, conventions and skills to clarify values and attitudes in exploring career options. • Participates in extra-curricular activities that are science career related.
• Identifies various science-related vocations or professions. • Describes benefits of working alone or with others to solve scientific problems. • Shows understanding of the importance of his/her work and the work of others in science. • Demonstrates his/her familiarity with scientific procedures by setting realistic goals and assuming responsibility for pursuing them. • Evaluates his/her work and the work of others in science realistically. • Uses the processes of scientific inquiry in identifying alternatives when solving problems or making decisions that affect self as well as others. • Seeks opportunities for helping others to learn science.	• Demonstrates his/her familiarity with scientific procedures by setting realistic goals and assuming responsibility for pursuing them. • Evaluates his/her work and the work of others in science realistically. • Uses the processes of scientific inquiry in identifying alternatives when solving problems or making decisions that affect self as well as others. • Seeks opportunities for helping others to learn science. • Demonstrates the ability to predict consequences and the impact of alternative decisions on self and others.

GUIDELINES FOR SELECTING A PROGRAM

compiled by
Ronald K. Toma - Central District

GUIDELINES FOR SELECTING A PROGRAM

Prior to the implementation or selection of a curricular program, information about its philosophy, objectives, scope and sequence, costs of materials and equipment, facilities requirement. and requirements for training of teaching personnel must be considered. In addition, availability of teacher time, costs involved in implementation and long-term support of the program and other areas of administrative, curricular, and instructional concern must be presented to teachers, school administrators, and the school community. This information can be communicated through meetings and/or informational workshops.

On the basis of their overall school and curriculum objectives, administrators and teachers should develop plans for implementation taking into consideration class schedules, teaching assignments, teacher preparation, classroom and laboratory facilities, field study sites, inventory of supply and equipment, and funds available to purchase materials and equipment. If at all possible, they should also consider the advantages of having at least two or more teachers implement the curriculum. Commitment by the total science department is desirable. These situations will allow for and encourage mutual support among teachers in sharing of educational agendas, problems, insights and, if necessary, the use of materials and laboratory equipment.

Community support for the program is encouraged throughout the various stages of implementation. Schools need to inform parents and others about the rationale and philosophy of the proposed curriculum program in relation to their own school objectives, of anticipated benefits and outcomes, the availability of resources to support implementation and evaluation results. They can suggest ways of involving the community in the program. For example, an advisory council composed of teachers, parents, students, administrators, and other community members might be formed to further support and coordinate implementation of the curriculum.

GUIDELINES FOR SELECTING A PROGRAM

A. Balance

A well-balanced program should provide opportunities to explore the physical, biological and earth sciences.

B. Emphasis

The emphasis should be on the development of attitudes and skills not merely subject matter.

C. Variety

The program should provide all students with a large number of diversified activities during the school year including experiences with experiments and demonstrations, reading about topics in science, giving reports, large and small group discussions, field trips, listening to resource persons, using audiovisual equipment, doing independent and group research. Activities should provide a wide range of individualization so that students with learning difficulties will receive reinforcement in their learning activities, gifted students will be challenged, and all students' learning will be maximized.

D. Provision for Materials and Facilities

It is useless to initiate a science program without the necessary supplies, equipment, and facilities. Before any science program is selected, provision must be made for the purchase of the equipment and supplies for the "doing" activities, textbooks, and supplementary materials. There must be adequate audiovisual equipment available and easily accessible films, filmstrips, slides, and other audiovisual materials. Provision must also be made for yearly replacement costs of consumable supplies and materials. Facilities must be planned to make sure that the activities in the program can be conducted within those facilities.

E. Teachers Assistance

In order to be proficient in teaching any given program, teachers must have the necessary background in the subjects covered by that program and familiarity with the program. Before a new program is initiated, professional books, source books, and curriculum materials should be made available to teachers and in-service training aimed at familiarizing teachers with the new program should be conducted. One (or more) teacher might be asked to serve as a consultant for the program; the selection of this teacher should be based on his/her expertise in that program. This teacher would work with other teachers in the school perhaps actually visiting classrooms during their science activity time while someone else takes over his/her class.

F. Sufficient Time

Sufficient time must be available during the course of the school day to complete activities in science. This is especially true for such activities as experiments and field trips. Sufficient time must also be provided for teachers to set up and/or test equipment for various activities.

G. Continuous Evaluation

Any science program must be continually evaluated by everyone involved in the program to be effective. Activities and materials should be scrutinized critically to make sure they are maximizing learning. New materials may be substituted when current materials are found to be ineffective or outdated. Activities must be analyzed for their effectiveness and those found wanting in learning outcomes should be replaced, deleted, or modified as needed. Even the evaluation techniques themselves should be examined periodically to be sure that maximum learning is taking place.

H. Criteria for Evaluation of Science Program Materials

1. General Considerations

   a. What is the philosophy of the program? Is it suited to the goals, methods, and purposes of the over-all program of the school? What instructional models would work best within this program philosophy? Does the program promote inquiry and thought? Does it stimulate new interest? Does it inspire more questions than it answers? Does it portray science as an exciting human adventure? Does it allow for imagination?

   b. Was the program field tested before publication?

   c. What is the evaluation of local teachers now using the program?

   d. Do the materials fairly represent all groups of people, and a variety of roles and careers?

   e. Does it provide for and support personal and/or group work?

   f. Are opposing sides of controversial issues presented?

   g. Do the materials avoid sex-role stereotyping?

   h. Can the material be easily integrated into the overall instructional program of the school?

2. Content

   a. Given the concepts to be taught, is the content appropriate to the developmental age?

b. Does the program develop the basic process skills as "making careful observations, measuring, classifying, hypothesizing, interpreting data, using space/time relationships, inferring, predicting, and communicating information"?

c. Is there a balance of skill and concept development?

d. Does the program provide experiences in the physical, biological, and earth sciences with equal emphasis.

e. Are the learning objectives clearly defined?

f. Do the objectives relate to the school science curriculum objectives? to the state science curriculum objectives?

g. Are the learning steps sequential?

h. Is there continuity of learning experiences from grade level to grade level?

i. Do the learning steps depend on isolated information?

How would the program accomodate mid-year transfer students?

j. Is there a systematic approach to reinforce learning?

3. Textbook and Other Reading Material

a. Is the vocabulary within the grasp of the intended reader(s)?

b. Is the style of writing appropriate to the subject, and clear and interesting to the reader?

c. Are explanations complete and easy to understand?

d. Does it avoid giving answers and squelching curiosity?

e. Do the visuals reinforce content and extend learning? Are they appealing?

f. Are the equipment, materials and language up-to-date?

g. Other considerations:

. Is the page format "clutter free"?

. Is the pagination adequate?

. Are visual cues sufficient (i.e. underlining, italics, boldface print, etc.)?

. Are the pages clearly organized (i.e. subheadings, margins, paragraph divisions, picture captions, etc.)?

. Is the binding durable?

. Is the paper of good quality?

4. Laboratory Activities

   a. Are the laboratory activities structured or open-ended?

      . If they are structured, are the student instructions easy to follow?

   b. Are student workbooks or data sheets provided?

   c. Are kits (equipment and supplies for the program) provided? for each lesson? for each unit?

   d. Are replacement parts (for expendables and broken equipment) easily obtained?

   e. If live materials are used, are they easily obtained? Can they be obtained locally?

   f. What is the average length of time needed to complete a laboratory activity? Is there time to allow for sufficient discussion and follow-up after each activity?

   g. Are the laboratory activities inter-related?

      . Does a second activity depend on the results of the activity before?

   h. Are the activities appropriate for the children in the age group for which they were developed? (Age and social needs)

5. Teacher Guides

   a. Is the Teacher Guide comprehensive?

      . Is the background information adequate? Is it easily understood or too technical?

   b. Is the Guide practical and easy to use?

      . Are step-by-step instructions provided in setting up a laboratory activity?

      . Does it list the materials needed?

      . Are there suggestions for laboratory management systems?

   c. Does the Guide offer suggestions for providing levels of challenge to students with various learning needs and abilities?

. Does it provide suggestions on how to choose activities or parts to use? What to do with children finishing at different times?

d. Does it provide the flexibility to delete or add other learning activities?

6. Evaluation

Does the program provide instruments for the evaluation of student progress?

7. Supplementary Materials

a. Are supplementary materials which are correlated to the program available?

. Filmstrips
. Filmloops
. Reading materials

HELPFUL HINTS AND OTHER IDEAS

TEACHING TOWARD INQUIRY: A THUMBNAIL SKETCH*

If you walk into a classroom and look around, you can't tell if the teacher teaches toward inquiry. It's not the way the students are grouped for instruction, the subject being studied at the moment, the books and magazines available, the number of students in the classroom, the visual aids in frequent use, what is or isn't displayed on the classroom bulletin boards, the location of the student's desks, whether there are movable walls or if team teaching or individualized instruction is to be found.

INQUIRY IN THE CLASSROOM IS DEFINED BY WHAT THE STUDENTS SAY TO EACH OTHER AND TO THEIR TEACHER--AND BY WHAT THEY DO AS THEY MATCH THEIR WITS WITH THE PROBLEM THEY'RE WORKING ON. To inquire is to direct one's moment-to-moment thoughts and actions in a way which, to the best of his/her present knowledge and belief, will lead at least to an increased understanding of the problem and at best to its solution.[1]

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[1]This definition of inquiry is taken from TEACHING TOWARD INQUIRY, Strasser et. al., National Education Association, Washington D.C., 1971.

*Copyright, 1973 by Ben B. Strasser, Gus T. Dalis, and the Office of the Los Angeles County Superintendent of Schools, as part of the Dalstra ITS Program. Distributed by the Teaching Strategies Center, Division of Curriculum and Instructional Services, Office of the Los Angeles County Superintendent of Schools. TSC 876-28

TEACHING TOWARD INQUIRY IS A WAY OF TEACHING IN WHICH THE STUDENTS:[2]

Create, use and evaluate a range of strategies useful in working to solve problems.	It isn't teaching the students the teacher's strategies for solving problems.
Uses a range of interrelated inquiry processes they feel they need as they build and test their theories.	It isn't conducting a twenty-questions game in the classroom.
Use accumulated concepts and skills to develop personal meaning. . . .	It isn't discounting or ignoring accumulated knowledge and conventional practices.
Search for rational explanations or solutions using data they or others have generated.	It isn't leading the students toward predetermined conclusions and explanations by giving them preselected data at the right time.
Explore the bases by which data, theories, explanations, and solutions are judged.	It isn't another way of covering a given body of content.
Learn to cope with their own frustrations as they work toward a problem solution.	It isn't protecting students from frustration by solving their problems for them.

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[2]This listing was adapted from materials originally developed by Fred Newton, Northwest Regional Educational Research Labs, Portland, Oregon, in FACILITATING INQUIRY IN CLASSROOM, p. 54, 1970.

IN TEACHING TOWARD INQUIRY, THE TEACHER:

Works toward helping students expand their repertoire of problem solving processes and strategies.	It isn't the way all teachers should work in all subject matter areas all of the time.
Makes it possible for students to build and test ideas for themselves.	It isn't something teachers do to or for their students.
Allows for student growth consistent with each student's natural developmental style.[3]	It isn't a series of pre-programmed lessons for the students.
Uses an infinite set of (1) ways of organizing students, (2) materials, and (3) facilities for instruction.	It isn't a group of twelve students who sit in a semicircle facing their teacher.
Uses specific teaching behaviors[4] gained through study, practice, use, and evaluation.	It isn't something teachers do "naturally" when they teach.
Works with all students of all levels in all subject matter areas.	It isn't a way of teaching specially identified students certain subject matter.

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[3]The Dalstra DEVELOPMENTAL LEVELS IN LEARNING TO INQUIRE, Teaching Strategies Center, Division of Curriculum and Instructional Services, Office of the Los Angeles County Superintendent of Schools, Downey, California. Copyright.

[4]The DALSTRA INQUIRY TEACHING BEHAVIORS, Teaching Strategies Center, Division of Curriculum and Instruction, Office of the Los Angeles County Superintendent of Schools, Downey, California. Copyright.

QUESTIONING--A MEANS TO INVESTIGATION AND INQUIRY*

True inquiry occurs in the classroom when it is the child who inquires. To inquire is to try and find out. This part of the presentation will explore ways that the teacher may use questioning techniques as a means of promoting children's investigation and inquiry.

Premises

- Inquiry comes about when the child is challenged and motivated to question and investigate.
- Inquiry on the part of the child does not occur when he/she is only being told or shown, or "parroting back" the thoughts of the teacher.
- To motivate children to inquire, the teacher must establish an "inquiry climate"--one of "wanting to know" or "find out".
- Children are more likely to formulate their own questions in a climate where the teacher is leading through questioning than they are in a didactic climate.
- The questioning techniques of the teacher contribute to an inquiry climate.
- Different categories of questions require different levels of thinking.
- There is an appropriate time and place for different categories of questions.

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*Presented at the National Science Teachers Association, Los Angeles, March 20, 1975.

A. C. Brewer, K-12 Science Coordinator, The School District of Springfield R-12, Springfield, Missouri

Ann Marshall, Consultant in Elementary Science, The School District of Springfield R-12, Springfield, Missouri

TECHNIQUES OF QUESTIONING

Performance Objective:

When asking questions, the teacher should be able to phrase them in such a manner as to bring about the optimum number of class responses.

When desiring to redirect the thinking of the class into other directions, the teacher should be able to phrase questions in such a way as to accomplish the redirective purpose.

There are many questioning techniques that can be used, each with a specific purpose. One such technique enables the teacher to involve many of the students of the class in a discussion (redirecting). A second technique is used when it is desirable to shift the trend or climate of the discussion or investigation (refocusing).

Technique	Characteristic	Key Expression
REFOCUSING	Expansion or restatement of prior statement or question. Question stated in different way. A "take-off" on another question. Either divergent or convergent.	Do you agree (disagree)? Suppose this condition were to change. What would happen? Suppose this were not true? Let's look at this from another way. Can you think of another way? Why?
REDIRECTING	A question open to many responses. Same question that may be answered in many different ways without restatement. Ideal when responses "bounce" from one student to another with no directive to respond. Usually divergent. May be used to refocus.	Do you agree (confirmation or expansion)? What do you think about this? Student may be called upon only by nod of head or encouraging glance. How would you do it different?

QUESTIONING TO AID IN THE READING OF A TEXT

Have you ever observed a class where one child was reading aloud in a stumbling manner (or perhaps very well), but the only one really involved with the content being read was the reader?

Consider the following paragraph from a grade 6 science text that directs the students into a simple activity.

> "Sometimes you need to know the volumes of objects that are irregular in shape. In this part of the unit, you will use two methods of displacement to find the volume of such objects.
>
> "Two things cannot occupy the same space at the same time. If a small object is dropped into a calibrated cylinder that has water in it, the water will be displaced. The water that is displaced will rise in the tube. The change in water level is equal to the volume of the object dropped into the tube. This is called the direct displacement method of finding the volume of an object."

One teacher might ask a child to read the paragraph aloud and explain what it meant, or ask other children to explain what had been read. This teacher might also complain that the textual reading level was too difficult.

Another teacher might show the class a calibrated cylinder with water in it and ask:

"What will happen to the water in the cylinder if an object is dropped in it?"

"What would this tell you about the object?"

"Let's read the paragraph to find how we can use the cylinder to find out more about the object."

"Now that you've read the paragraph, what can you find out about the object? Read where it tells you, John."

"Find where it tells you why the water rises in the tube."

"What method would you be using to find the volume?"

"What do we mean by water being displaced? Read the part that tells, Susie."

"How many methods can we use to find the volume of irregular solids?"

"When might you not be able to use the method of direct displacement?"

The key to being a good "Questioner".

Listen! Listen! Listen!

SOME PRINCIPLES OF GOOD COMMUNICATION*

Dr. R. H. Oyler

1. Communication is risky--so it's rarer than talk, rituals, manipulative "games", and "discrete silence."

2. Two individuals must both care--share a need, problem, goal or strong feeling.

3. Each must be willing to work actively at honestly sharing ideas and feelings--willing to self-disclose as well as listen a long time.

4. There must be ample time without interruption given, and in privacy or shelter or safety.

5. Both must look and listen carefully, intently. Person A will have to put Person B's words and feelings into his own words and body language so accurately that Person B recognizes the accuracy of A's "feedback." (This is one definition of communication.)

6. Temporarily, both parties must be "the same psychological size"--A's feelings and ideas are just as important as B's (e.g. teacher and student, parent and child, boss-employee). Communication and deep human love occur only between equals!!

7. Much more attention and energy must be devoted to feelings than Americans usually devote to them. Values and feelings often are more important than "content" or dictionary meanings of words used in messages. This is why "talking it over" or "raps" are often ineffective.

8. Honest sharing of feelings or "communication" does not mean A and B are free to "chop" or to "zap" each other; to tell the other the stark, painful truth about their looks or behavior in a hostile way; to "put down" or "win"; to hurt. Communication seeks solutions, clarity, relief--as Dr. Tom Gordon says, "A no-win-no-lose" outcome.

9. Communication requires that we try hard to empathize (to put yourself into another person's place or skin). There's a reason for what people do. Be generous in interpreting human motives: look at relationships and circumstances more often than you look at "personality" or "character." Seek to understand--not to approve, disapprove, label, or explain the history of behavior.

10. Human "communication" is not solely a matter of "body language", touching, "vibes", etc.--it's both non-verbal and verbal. It's both logical and illogical; both rational and irrational.

11. True "communication" can occur between people of any age, culture, or ethnic group. "Generation Gaps" and prejudice can be overcome by skilled communication and patience.

12. "Communication" is not quick and easy, although it comes naturally to some people.

13. Different meanings for the same word disrupt "communication." You must question and clarify specific usage (e.g. Did you mean-----? or, Can you tell me more about that, I'm unsure --- confused).

14. Formal education and a person's ability to "label" or to explain human behavior intellectually or generally (abstractly) can be an obstacle to successful "communication" with people. This takes us away from "I and Thou, Here and Now".

15. The major values, benefits or important parts of "communication" are: verification, clarity of meaning, removal of doubt, intimacy, reassurance, ability to collaborate creatively, learning, behavioral change, etc.

16. "Communication" is not always appropriate, necessary, or desirable between people. Don't feel you can or must communicate with everyone all the time.

17. Communication often involves messages like, "you may be right.....I'm sorry.....I may have been wrong.....now that I really think about it..... I guess I believed a rumor.....I shouldn't have taken it for granted that you knew.....I was angry (afraid, worried, etc.).....let's slow this down.. I thought you.....I want you to know I forgive you.....let's try again..... Oh, now I see what you mean.....etc.

18. Each day, there are too many "mixed messages" sent and received for hurt, growing, confused, or suffering people to trust the sender. So, you hear, "I just don't dig him."

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*Taken from Student Oriented Drug Abuse Project. Resource Handbook, Butte County School System, Oroville, California.

TEN LITTLE BIG THINGS THAT TEACHERS CAN DO TO ENHANCE THE DEVELOPMENT OF POSITIVE SELF-CONCEPTS*

By George L. McMahon

1. Speak to each student in your class each day.
   Collectively, or better yet, individually, people like to be acknowledged.

2. Make positive statements as often as possible.
   No human being can survive a steady barrage of no's and don'ts.

3. Dispute only inaccurate facts, accept opinions.
   Opinions need to be accepted with the understanding that they may be based upon different values.

4. Reach out and touch students when needed.
   A handshake or hand on a shoulder communicates much better than words; "I like you," "I care about you." A refusal to touch communicates the the opposite.

5. Smile.
   It is contagious.

6. Address students as responsible human beings.
   In order to be responsible people must have responsibility.

7. Be honest with students.
   They will learn that you trust them.

8. Express anger toward misbehavior rather than human beings.
   Better for a student to think "I did something bad" rather than "I am bad."

9. Stay in the present time.
   Recalling past behavior merely causes hurt in the present.
   Dealing with present behavior can be a learning experience.

10. Work to develop your own positive self-concept.
    Happy, well adjusted, self-aware human beings who genuinely care for other people, make good teachers.

*Taken from Student Oriented Drug Abuse Project. Resource Handbook, Butte County School System, Oroville, California.

KILLER PHRASES THAT STIFLE CREATIVITY*

A. Conduct a Class Discussion Around the Following Questions:

1. Have you ever worked very hard at something you felt was not understood or appreciated? What was it? What was said or done that made you feel your effort was not appreciated?

2. Have you ever wanted to share things - an idea, a feeling, something you've written or made - but were afraid to? Were you afraid that people might put you or it down? What kind of things might they say or do that would put you, your ideas, your feelings, or your achievements down? Make a list of all the things people say or do that make you feel like not sharing again.

B. Introduce the concept of "killer statements and gestures" to the students. Many of us have many feelings, thoughts, and creative behaviors that are killed off by other people's negative comments, physical gestures, etc. Some killer statements that are often used (even by teachers!) are:

- We don't have time for that now.
- That's a stupid idea. You know that's impossible.
- You're really weird!
- Are you crazy? Retarded? Kidding me? Serious?
- Only girls/boys do that!
- Wow, he's strange, man, really strange!
- That stuff's for sissies.

C. Tell the students that they're going to be social science researchers for the day. Ask them to keep a record of all the killer statements they hear in school, at lunch, at home and at play. Discuss the findings with them during the next class.

D. Some other ideas are to have students make collages of killer statements and gestures. Discuss how killer statements serve you. What do they protect you from? Are there things that you would really like to say but are afraid to disclose and, therefore, substitute killer statements. (For instance, saying "That's for sissies!" instead of "I'd like to do that, but I probably wouldn't do very well," or "That's not a bad shot for a girl," instead of "I like you."

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*Taken from Student Oriented Drug Abuse Project. Resource Handbook, Butte County School System, Oroville, California.

PROBLEM SOLVING BEHAVIORS

1. Identify the problem; establish a set by:

    a. Recognizing problem exists--identifying some of the boundaries of problem.

    b. Defining problem and parts.

2. Generate possible solutions by:

    a. Organizing the data--making it easier to see relationships.

    b. Asking questions which may lead to modification of possible solutions.

    c. Identifying variables and controls--variables may influence outcome of investigation--as necessary in order to understand the concept of controlled experiments, to make any sort of appraisal of their designs, and to make an intelligent interpretation of possible results.

    d. Explaining and answering questions.

3. Formulate a hypothesis.

4. Test the hypothesis and collect data.

5. Review the data and draw conclusions.

6. Receive feedback on the success or failure of the conclusion:

    a. Accepting critical and/or positive feedback.

    b. Acting on suggestions in an appropriate manner which may necessitate going back to the previous stages, or may result in solving the problem.

STATEMENTS THAT DESTROY IDEAS AND CHLOROFORM CREATIVE THINKING*

We've never done it that way.
We haven't the time.

We've tried that before.
We're not ready for it yet.

Good ideas, but our school is different.
All right in theory, but can you put it into practice?

Too hard to administer.
Too much paperwork.

Too early.
It's against school policy.

You haven't considered.....
It's not in the budget.

A swell idea, but.....
There are better ways than that.

Let's shelve it for the time being.
It's not good enough.

They won't let us.
Too modern.

Too old-fashioned.
You don't understand our problems.

Why start anything now?
We're too big for that.

The experienced teachers won't use it.
We have too many projects now.

What you're really saying is.....
I just know it won't work.

Let's be practical.
Let's form a committee.

Let's not step on their toes.
That might work for someone else, but.....

What's the matter with the way we've always done it?

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*Taken from Student Oriented Drug Abuse Project. Resource Handbook, Butte County School Systems, Oroville, California.

SOME COMMON DEFICIENCIES IN STUDENT'S UNDERSTANDING OF SCIENCES*

Understanding About the Scientific Enterprise

Students lack appreciation of:

1. Influence of people and government on scientific activity.
2. Role of creative endeavor in science.
3. Dynamic, expanding, and on-going nature of the scientific enterprise.
4. Function of scientific journals.
5. Contributions of past findings in scientific research and the importance of communicating the findings and scientific research.
6. Functions of scientific societies.
7. Contribution of scientists in many countries in advising United Nations (UN) agencies.

Understandings About Scientists

Common misunderstanding are that scientists:

1. Do not need to be creative.
2. Use "scientific attitudes" when they were doing almost anything.
3. Spend every possible minute in the laboratory.
4. Have honesty and self-criticism as a personal characteristics.
5. Are born with special scientific aptitude.
6. Are serious and intelligent people.

Understandings About the Methods and Aims of Science

Students commonly exhibited a lack of appreciation:

1. Of the functions of scientific models.
2. Roles of theories and their relationships to research.
3. Of the distinctions between hypotheses, laws and theories.
4. Of the relationship between experimentation, models and theories and absolute truth.
5. That science is not solely concerned with collection and classification of facts.
6. Of what constitutes a "scientific explanation".
7. Of the difference between science and technology.
8. Of the close interrelationships between and interdependence of the different branches of science.

*Mackay, Lindsay D., "Development of Understanding about the Nature of Science", Journal of Research in Science Teaching, Vol. 8, No. 1, pp. 57-66, 1971. (Reprinted by permission of John Wiley & Sons, Inc.)

A STUDENT GUIDE FOR PROJECTS--
SCIENCE FAIR AND OTHERWISE

THE SCIENTIFIC METHOD:

This tool is not really unique to science, for this method is nothing more than critical thinking. It just happens that we, up to now, have been more succesful in applying critical thinking to problems dealing with the physical environment, taken in its broadest sense. The scientific method, as outlined here, is not unique to science. In fact, it has been used by observant humans ever since people became aware of the surrounding world. Thus, the scientific method, far from being the invention of scientists, is a part of us. It just happens to be a good framework upon which to start for an understanding of systematic problem-solving in science.

WHAT IS THE PROBLEM?

What is the first step in the scientific method? It is the formulation of the problem. It is not a general statement about what you are going to study. Rather, it is the specific question that needs asking about the specific problem you are going to investigate. It needs to be worded very carefully, and restricted to the one problem you plan to study. The asking of that first question is undoubtedly the most difficult and the most inportant step in your whole Science Fair project. Fortunately, this is one part of your exhibit where you can get as much help from any one as you possibly could want. You can talk about it with your friends, with your teachers, with your parents and, most importantly, with scientists who have gone before you in this area of work and have written on the subject.

WHAT ARE GOOD REFERENCES?

This brings us to the subject of references. Somewhere along the way you have heard that it is 'nice' to have some references cited in the report that accompanies the exhibit. This is true. It is true also that the references cited should be relevant to the problem; that they should have been used in developing your thoughts, ideas, hypotheses, or equipment and that they should continue to be helpful when you discuss your results in the light of corroborating or conflicting evidence. What would you consider a good reference in the field that interests you? Where would you find it? Would you be more likely to encounter it in a scientific journal published in this country or abroad by a society of specialists in that field; in an article published by a recognized authority either in a scientific or even a semi-popular magazine or in a textbook written in a scholarly manner--one that explores in depth the many facets of the field? Would you be more likely to encounter it in a newspaper, in a brochure published to extoll the virtues of a particular product, or in a Sunday supplement? We shall leave the judgment to you.

ARE COLLECTIONS SCIENCE?

In a number of disciplines, a collection is a very important aspect of the development of that science. This is particularly true in botany, zoology, geology, and archaeology. You may have noticed that few collections receive prizes in Science Fairs. This is not because the judges do not appreciate a well done, carefully preserved, and correctly identified collection. It is rather because a collection is only a preliminary step towards obtaining a tool that allows the testing of a hypothesis (such as a hypothesis relating to taxonomic relationships, or evolutionary trends, or the effects of certain treatments on related or dissimilar organisms). A collection by itself, regardless of how well done it may be, stands little chance of winning in the Science Fairs. We hope that this will not discourage those of you interested in collecting specimens of plants, animals, artifacts, rocks, or shells. Please continue to do so, because this is a very interesting and fascinating part of science. Do remember, however, that the collection is only one step in the recognition of materials at hand that need study--materials with which you can perform experiments, test hypotheses, and use the scientific method.

ARE GADGETS SCIENCE?

Another observation needs to be made. The judges are considerably more interested in ideas than in gadgets. This does not mean that a well designed instrument, successfully constructed for a specific purpose, is not appreciated. It does mean that the thought--and the originality of thought--behind the exhibit weighs much more heavily than the gadgetry or instrumentation used. The judges are aware also that commercial concerns sell kits to make certain types of equipment. There is nothing wrong with using a kit. The resulting instrument probably will work and look at least as well as the one you make yourself. It may even look better. But that really is not the point. The point is whether the instrument you built, either from scratch or from a kit, was used by you within the framework of the scientific method. That is the one criterion to consider.

WHAT IS THE OBJECTIVE?

So now, after a great deal of reading, thinking, and talking, you have selected a fairly specific problem to investigate. Your reading has been selective and limited to a narrow segment of your field of interest, and you are now ready to write down the question that you will attempt to answer. You are ready to state the objective or objectives of your investigation. That is the hardest part of the job, because from now on everything that you will do--and much of it will require a great deal of time, effort and concentration--must follow from this first step.

WHAT ABOUT ORIGINALITY?

Perhaps you realize that judges of the Science Fair consider very highly what is termed "originality". A great deal of the originality has its source in the objectives. Of course, the judges are aware that an original thought is a hard thing to come by. They know that many successful scientists may have had only one original thought in their entire career. So the judges are looking for a thought which, even though it may not be new to the world, in effect was new to the creator of the Fair exhibit. It may be something widely known and well understood considered in a new light or in a simpler or more elegant fashion. It may be a demonstration presented in a slightly new way, or an application in a new environment or in the light of new developments. This does not mean that the exhibit should be complicated; it could be very simple and still be original.

WHAT IS HYPOTHESIS?

Once the objective has been clearly defined, what is the next step? It is the development of a hypothesis that will be shown to be acceptable or not acceptable in the light of the data obtained. A hypothesis is a statement of what may be believed to be, or not to be, the true situation; and it may be accepted or rejected when the data have been collected and examined critically. A hypothesis is not true or false. It provides a basis, a guide, for the experiment to follow. The experiment is the framework that will permit the testing of the hypothesis in an orderly and logical sequence. Thus, an experiment, however simple it may be, will have to be designed. The designs available are many and varied, and different procedures may be used in different disciplines however, the experiment must be designed in a manner that will ensure that the hypothesis can be tested and that valid and meaningful data will be obtained.

The conclusions that can be drawn from the data in the light of the situations under which they were obtained allow you to accept or reject the hypothesis within pre-selected limits of probability.

WHAT SHALL I MEASURE?

At this point, you should consider the matter of analysis and interpretation of data; this must be done now, before any data are obtained. You must consider what you are going to do with the data and how they are likely to be interpreted before any are obtained. You may find, much to your dismay, that the data you are likely to obtain from the experiment you had in mind to satisfy the testing of the stated hypothesis would in fact not allow you to do so. Surely there is no merit in obtaining data that will shed no light on the acceptability of the hypothesis. So, to satisfy yourself that you will obtain the type of evidence needed to evaluate your hypothesis, you may need to clarify the objective, rephrase the hypothesis, change the experimental approach, or re-evaluate the type of data you will measure.

WHAT SHALL I MEASURE? (continued)

In most of the scientific disciplines with which we are familiar, probabilities of the occurrence of events must be considered. Thus, data should be obtained in such a fashion that they are likely to be representative of the general phenomenon they purport to represent. The necessary precautions in interpretaion that result from statements of probability should be observed, and expressed as statistical inferences. It is widely recognized by scientists that any one experiment, or any one group of experiments, does not, in the majority of instances, comprise the whole population of events to be studied. So, if a portion of that population studied in an experiment is to be used to predict the behavior of the remainder of the population, statements of probability, the likelihood of the behavior of the sample being the same as the universal behavior, are a necessity. In order to achieve this, it will be necessary to use a valid statistical design.

WHAT TECHNIQUE SHALL I USE?

Now let us see where you are. You have stated an objective. You have developed a hypothesis. You have designed an experiment. You have selected the form of data you hope to obtain and the type of statistical analysis you will use to extract valid and meaningful information from the data. What is left? At this point, most people might think that you have done nothing; but, in fact, you have completed a substantial part of the painstaking preparation that is required for a successful Science Fair exhibit. Now you are ready to select the technique, construct the gadget, grow the plants, feed the guinea pigs, blow up the test tube, or slice the specimen. You are ready to carry out the experiment. You will draw upon the knowledge you have acquired from the study of the reference material; you will use your ingenuity and intuition, your dexterity and your powers of observation. You will be as careful and precise as possible; you will keep a detailed record of everything you do, see, and measure.

WILL IT WORK THE FIRST TIME?

It is quite likely that things will not happen as you might have expected they would. When this occurs, you will realize that it is because your techniques were imperfect, your control of allied factors was inadequate, or your sampling of the whole population was insufficient. So you will refine your techniques or instrument; or you will increase the size or the number of samples; or you will more adequately consider, eliminate, control, or take into account other factors.

At this stage, you may say,"Well, that is very fine for a team of scientists working with million-dollar budgets, but this approach is not possible for me in the space provided for a Science Fair exhibit!" We would disagree with you and point out that it is not the complexity of the experiment that matters; it is the approach, the methodology (in fact, the simplicity with which the scientific method is used) that is relevant. There is no need for ten or twenty treatments if the hypothesis is set up to evaluate the effect of two treatments.

KEEP COMPLETE NOTES!

Since it is difficult to remember correctly and completely all pertinent details of events during the course of an experiment, it is very important that a workbook be a part of any research project. This report should be complete and accurate, it should be neat and easy to read; and it should show everything you did, considered, measured, or otherwise accomplished in preparing for the exhibit. This is the place where more complicated aspects of your experiment can be enlarged upon, tabulated, indexed, and presented.

WHAT DO THE DATA SAY?

Once you have a hypothesis, have carried out a preliminary and then maybe a second experiment, and have organized your record book, you are ready to summarize the data and interpret them. The interpretation need not be long or involved, but it should be valid. Not only should it be valid, it should also take into account whether or not the data you obtained were in agreement with or at variance with knowledge previously ascertained and published. It should consider also the limitations imposed in your study by the techniques utilized. It should recognize the probabilities that are considered necessary in your particular discipline for acceptance or rejection of the hypothesis. It should acknowledge the possibility of alternate conclusions.

WHAT IS MY CHECK?

However, remember that in order to measure the effect of a specific treatment there must be the control or no treatment. We would caution you to be absolutely certain that the control you use is in fact a control. It should differ from the treatment only in the one factor you are studying. We cannot over-emphasize the absolute necessity of having not just a control, but a meaningful and adequate control in any experiment.

Due to the uncertain nature of experimental research, it is quite probable that your first experiment will not meet your standards. Even your second or third attempts may not satisfy you. So you will want to start in plenty of time to allow yourself the possibility of repeating or modifying your technique. It may be that the first year you enter the Science Fair, you will feel discouraged with the results of your efforts. Please do not give up! You have learned a great deal from your experience, and next year you may do much better.

SHOW YOUR BUILDING BLOCKS!

Those of you who experimented with live plants or animals may have difficulty demonstrating in the exhibit the same evidence that led you to your original conclusions. If this happens, be sure to indicate that you have recognized this situation. You should point out that you attempted to make the exhibit complete by substituting new test material. You should indicate why this substitution had to be made. If the evidence shown by the biological material in the exhibit is different from that which led you to your reported conclusions, you might suggest the reasons that you suspect are responsible for this difference.

AN EFFECTIVE EXHIBIT:

Finally, you can prepare your exhibit. In the space allotted, somehow, you are going to recapitulate all you did, from objective to interpretation. You will show your objective, your hypothesis; you will demonstrate your technique or instrument; you will present your results and indicate your conclusions. Naturally, you will want your exhibit to be neat, clear, well-presented and uncluttered. You will use graphs or tables so that people not as familiar with your data as you are will understand them easily. You will want also to be sure that your presentation is impartial, honest, unbiased, and objective. Lastly, your descriptions and results should be written in a language we all understand, and that is English. You should select words that mean what they say, words that are specific and descriptive, words that are spelled correctly. You should assemble them in grammatically acceptable sentences.

SUMMARY:

In summary, then, a Science Fair exhibit, in order to be successful, should show evidence of the thoughtful use of the scientific method for the demonstration or investigation of some phenomenon. It should contain a statement of the objective, a hypothesis, a rational approach to accepting or rejecting this hypothesis with a recognition of previous knowledge and probable limitations, and an interpretation of the results presented in a clear and concise manner. A superior exhibit will, in addition, show evidence of originality of thought, idea, or approach. (And it really does not matter much whether the approach is to a new or to an old problem.)

Remember always, though, that your main objective is to think creatively. You can apply this ability to solving problems not only in science, but also in living.

So, students of science, we wish you not luck, but fun. For satisfaction and enjoyment are what you will find on the road to learning more about the universe in which we live.

SCIENCE LABORATORY SAFETY AND PRACTICES

SCIENCE LABORATORY SAFETY AND PRACTICES

This portion of this guide has been prepared to assist the classroom science teacher in providing a safe laboratory environment that does not, at the same time, unduly restrict scientific activity. The suggestions proposed are intended as guides for the teacher, but do not constitute guarantees against accidents.

SAFETY PROGRAM IN SCIENCE

The safety of pupils and teachers in science classrooms and laboratories requires good planning, constant practice of safety as a habit, and development of attitude. Every individual must realize that the laboratory is a place where one has the safety responsibilities to oneself and to one's fellow workers.

The actions of the teacher teaching science will determine the effectiveness of safety practices and procedures. Concern for safety precautions must be communicated to and shared by the pupils. Every classroom demonstration and laboratory exercise demands safety considerations.

Safety should be taught through understanding and respect for potential hazards which equipment and chemicals may present when improperly handled, rather than through fear. Proper supervision and training of pupils, availability of safety equipment, and constant effort to improve safety practices and procedures make the science laboratory a place where effective learning takes place and accidents minimized. A science laboratory which incorporates safety as part of its everyday routine can offer more opportunity for free inquiry.

Certain safety steps should be standard operation procedure for administrators, teachers and pupils. They all have definite safety responsibilities.

RESPONSIBILITIES OF SCHOOL ADMINISTRATORS

1. Principals shall be responsible for the administration and supervision of laboratory safety and practices for the school science program.

2. Principals should insure that all science teachers certify annually that they have received and read this guide.

3. Principals will take immediate corrective action to reduce or eliminate safety problems. This should include taking preventive measures like maintaining fire fighting and safety equipment in operable condition.

4. Principals or their designees are responsible for administering emergency first aid to sick or injured students.

RESPONSIBILITIES OF DEPARTMENT AND/OR GRADE LEVEL CHAIRMEN

The chairman should:

1. Orient new teachers and substitutes as to responsibilities of the teacher for science safety.

2. Perform tasks assigned by the principal in administering the safety program for the school.

3. Conduct departmental or grade level meetings to discuss science safety-related topics.

4. Supervise the safety program for the department or grade level.

5. Devise, with department or grade level cooperation, suggestions for improvement of the science safety program together with recommendations to be submitted to the Program Specialist for Science for the development of a more comprehensive manual.

RESPONSIBILITIES OF TEACHERS OF SCIENCE

Teachers must at all times be concerned with making every reasonable effort in the prevention of accidents. This requires training in safety practices and constant awareness of pupil behavior in the laboratory. Teachers must be aware of the application of safety practices and must display exemplary behavior regarding accident prevention.

1. Teachers should be familiar with the school procedures, in case of an accident or injury. See school's Teacher's Handbook.

    a. The principal and department chairman should be notified of the accident immediately.

    b. A properly trained person will administer first aid if necessary.

    c. An injury which requires medical care should be treated only by a physician.

    d. Prepare department accident report form (See sample, Form 411* in Appendix B) immediately after an accident occurs. This will provide essential information for defense or disposition of suits against the State and will provide such information to correct the cause of the accident.

2. Teachers should offer instructions on laboratory safety procedures at the beginning of the school term. Students should be given specific instructions regarding the safe use of equipment and materials for each laboratory activity.

3. Teachers should make regular laboratory inspections and notify the principal and department chairman of the existence or development of any hazards.

4. Teachers will require pupils to use protective devices such as laboratory aprons, safety eye shields, and gloves as they perform investigations for which these devices are appropriate. (Shoes are appropriate safety devices when using acids or caustics.)

5. Teachers should take precautions to shield and place pupils at safe distances from demonstrations when there is possibility of spattering of chemicals, chance of a flash flame or explosion.

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*For further reference, refer to Policy 1710-14.1, "Emergency Care for Sick or Injured Students," Policies and Regulations, Department of Education Code.

6. Warning signs should be posted in all areas where poisonous materials, high voltage electricity, pathogenic organisms, or radioactive materials may be located.

7. When working with limited quantities of equipment, each student group should be small enough to avoid confusion which might result in an accident.

8. Laboratory experiments and exercises which involve potential hazards should be previously tried out by the teacher to determine whether the lesson can be performed safely.

9. Devices, equipment, and individual projects brought in by pupils should be pretested before use as a demonstration in class. Even then, extra precautions must be exercised during the actual demonstration.

10 Teachers should be well-trained in first aid and be able to render this help when needed. It is recommended that a current first aid certificate be maintained by teachers.

11. The areas around the safety shower, fire blanket box, eye wash fountain, fire extinguisher, and first aid kit should be kept open for quick access in case of emergencies. All aisles and exits must be kept clear at all times.

12. Teachers should keep all bottles and containers of chemical materials labeled at all times. Liquids and solids in unlabeled containers should be discarded if the material can be identified and proper disposal procedures are known. (Presently a task force involving Department of Health personnel is studying the problem of chemical disposal. When these procedures for the safe disposal of such materials have been finalized, the information will be disseminated. Until then, store unlabeled containers where they will not be used. Maintain the labels of all other chemicals so that they may be readily identified.)

13. Substitutes for potassium cyanide should be used in insect killing jars made available for student use.

14. Teachers should supervise students at all times.

15. Pupils should be warned of the hazards of conducting home projects involving explosive mixtures, poisons, pathogenic bacteria, and high voltage electricity (including house current).

In general "reasonable care" may take two forms. A teacher must not do anything that a reasonable person would recognize as being potentially dangerous. Neither may teachers fail to do something that would be necessary to protect the safety of their students. Thus, negligent conduct may take two forms - the performance of an act that puts pupils in danger, or the failure to take an action to protect them.

RESPONSIBILITIES OF PUPILS

1. Pupils should be familiar with safety procedures and take appropriate precautions at all times to insure the safety of every individual in the laboratory.

2. Pupils should follow instructions explicitly and perform only authorized experiments whenever hazardous conditions exist or potentially dangerous materials are available.

3. Pupils should practice good housekeeping -- clean up spilled materials immediately, return equipment and chemicals to proper places, and dispose of waste materials into proper receptacles.

4. Pupils should wear appropriate personal protective devices such as aprons, safety glasses and shoes while performing laboratory activities.

5. Pupils should know the location and proper use of the safety shower, eye wash fountain, fire extinguisher, and first aid kit.

6. Pupils should report all accidents and potential hazards to the teacher immediately.

7. Pupils should consider every chemical as toxic and take precautions against poisonous fumes, corrosive materials, explosions, and fire. Never taste, smell, or touch any chemical unless instructed by the teacher.

8. Pupils who are allergic to substances such as formaldehyde, alcohol, or certain plant and animal materials should inform the teacher and ask to be excused from working with them.

9. Pupils should never clown, play practical jokes or take chances while working in the science laboratory.

LABORATORY SAFETY FOR SPECIFIC ACTIVITIES

Every teacher of science in elementary and secondary schools should know of the recommended safety practices and the potential hazards of certain laboratory activities described in this manual. Safety procedures and practices are grouped under the following sections:

- Living Things
- Chemicals
- Radiation and Radioactive Materials
- Rocketry
- Electricity

· Glassware

· Field Trips

I. USE OF LIVING THINGS

A. Studies with Live Animals

Humane use of living animals in a science classroom is a proper and necessary educational activity. The basic aim of scientific studies that involve animals is to achieve an understanding of life and to advance our knowledge of the processes of life. Such studies lead to a respect for life.

1. The science teacher or a qualified adult supervisor must assume overall responsibility for the purposes and conditions of any study that involves living animals.

2. Studies involving the handling and use of animals must be made in a humane fashion. Anesthetics, if applied, must be appropriately matched to the organism and type of observation. Much can be learned about life processes from use of protists or other invertebrates rather than vertebrates.

Dissection: Science at the elementary school level offers opportunities for early development of a healthy attitude towards reverence and respect for life. Laboratory exercises which involve dissection of pithed frogs and other animals are not appropriate in elementary science.

In the secondary school, pithing of frogs and other animals should be done privately by the teacher or laboratory assistant and not before a class to avoid unfavorable psychological effect on sensitive students.

3. The comfort of the animal used in any study will be a prime concern of the teacher and/or student investigator. Gentle handling, proper feeding, and provision of appropriate sanitary quarters shall be strictly observed at all times. Any experiment in nutritional deficiency may proceed only to the point where symptoms of the deficiency appear. Appropriate measures must then be taken to correct the deficiency. Otherwise, the animal must be disposed of by humane methods.

4. All animals used must be lawfully acquired in accordance with state and local laws.

5. Animals should not be kept over school vacation periods unless adequate housing is provided and a qualified caretaker is assigned specific duties of care and feeding.

6. Any special study (high school) involving anesthetic drugs, surgical procedures, pathogenic oranisms, toxicological products, carcinogens, or radiation should be undertaken only under the direction of a biology teacher or a biologist, physician, dentist, or a veterinarian trained in the experimental procedure who assumes direct responsibility for the proper conduct of the experiment. Requirements of the State Department of Health concerning handling of radiation and pathogenic organisms must be met.

7. Animals that are poisonous, vicious or may harbor parasites and require much care to avoid student injury should not be kept in the science room.

8. The Department of Agriculture, State of Hawaii, prohibits the introduction and harboring of certain animals which are a threat to agriculture and natural resources of the State, such as: gerbils, hamsters, snakes, and snapping turtles. For other animals not listed, contact the Plant Quarantine Office, telephone 533-4720, 701 Ilalo Street, Honolulu, Hawaii 96813. All animals and organisms brought into the State require a permit obtained from the Department of Agriculture.

B. Studies with Plants

1. Poisonous Plants: Teacners should become familiar with common poisonous plants found in Hawaii and caution students in the handling of them.

   Students should not:

   a. Place parts of plants in their mouths.
   b. Rub sap or fruit juices into the skin.
   c. Inhale or expose skin and eyes to the smoke from burning of plants.

2. Bread Mold and Pollen: Flowers and bread mold should be carefully handled to prevent excess distribution of pollen and spores because of sensitivity of some students to them.

C. Microorganisms and Parasites

1. Bacteriological studies should involve non-pathogenic bacteria.

2. Fleas, ticks, and mites can be carriers of pathogenic organisms and must be handled with caution when used as experimental animals

D. Studies Involving Humans

1. Blood Typing: No student should be required to type his own blood. If this exercise is conducted, parental consent should be obtained. Only individually sterilized and wrapped lancets should be used.

2. Epithelial Cheek Tissue: Students should use a sterile swab or flat end of a toothpick to obtain cheek cells. Any sharp instrument such as a needle or scalpel should not be used.

II. USE OF CHEMICALS

A. First Aid -- Chemical Burns

Use emergency shower if large area of body is affected. In case of chemicals in eyes, use eye wash fountain.

1. Acids: Wash the affected area with large quantities of water followed by application of a solution of baking soda (sodium bicarbonate).

2. Alkalis (Bases): Wash the affected area with large quantities of water followed by application of vinegar solution.

B. Handling Chemicals

(1) General:

1. Caution students never to mix, touch, taste, heat, or inhale chemicals unless the teacher has instructed the class that it is safe to do so.

2. When handling chemicals, it is recommended that goggles and an apron be worn.

3. Adequate room ventilation and use of the fume hood are necessary when organic solvents such as benzene, carbon tetrachloride, chloroform, methyl alcohol and acetone are used and when toxic gases such as hydrogen sulfide, sulfur dioxide and chlorine are generated.

4. Biological specimens preserved in formaldehyde or denatured alcohol should be thoroughly washed in running water before use. Wear rubber gloves or use tongs when handling specimens. Adequate ventilation should be provided as formaldehyde fumes are irritating to the eyes and throat.

5. Avoid contact of the skin with the following partial list of toxic materials during handling:

Bromine (liquid)	Mercury
Carbon tetrachlorides	Nitric Acid
Chromates	Phenol
Dichromates	Phosphoric acid
Formic acid	Potassium hydroxide
Hydrochloric acid	Sodium hydroxide
Hydrofluoric acid	Sulfuric acid

(2) Acids and Bases:

1. When diluting acids, especially sulfuric and phosphoric, always pour acid slowly into the water with constant stirring to avoid soattering. Use Pyrex containers to avoid cracking of glass due to heat of reaction.

2. Always use diluted acid unless instructions call for concentrated acid.

3. Dilute all acid or alkaline solutions with copious quantities of water before discarding into sinks. Use running water from faucets to wash solutions down the drain.

(3) Heating Chemicals:

1. Heating of flammable reagents such as organic solvents, alcohols, and benzene should be over a water bath or an electric hot plate and not over an open flame.

2. When heating liquids, hold the test tube at 45° angle with the mouth of the test tube away from yourself and others.

3. To avoid fire or explosion, use flammable, volatile liquids at a safe distance from open flames.

(4) Dangerous Reactions:

1. Ultra-toxic gases such as hydrogen cyanide and phosphine must not be prepared in the laboratory. It is recommended that the generation of halogens be avoided.

2. White phosphorus should be handled by teachers only. Phosphorus is extremely hazardous and it is best not to have any in stock. Use red phosphorus in place of white phosphorus whenever possible.

3. Unless used in very small quantities, the following are some combinations of chemicals which may result in dangerous explosions:

a. Sodium or potassium metal with water.

b. Ammonium nitrate, zinc powder, and small amount of water.

c. Potassium chlorate and sulfuric acid.

d. A halogen and ammonia.

e. Potassium nitrate with sodium acetate.

f. A nitrate and an ester.

g. Peroxides with magnesium, zinc, or aluminum.

h. Phosphorus with nitric acid, a nitrate, or chlorate.

i. Mercuric oxide with sulfur

Explosive mixtures should not be used unless they serve an important purpose in the science lesson. Extreme care must be taken to protect the class from spattering, fumes, and flying particles.

4. Incompatible chemicals result in hazardous conditions, including explocions as in #3, under Acids and Bases, when combined.

Contact should be avoided between:

Alkali metals, such as calcium, potassium, and sodium with water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.

Acetic Acid with chromic acid, nitric acid, hydroxyl-containing compounds, ethylene glycol, perchloric acid, peroxides and permanganates.

Acetone with copper (tubing), fluorine, bromine, chlorine, iodine, silver, mercury and their compounds.

Ammonia, Anhydrous with mercury, halogens, calcium hypochlorite, hydrogen fluoride.

Ammonium Nitrate with acids, metal powders, flammable fluids, chlorates, nitrates, sulphur and finely divided organics or combustibles.

Aniline with nitric acid, hydrogen peroxide.

Bromine with ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, and finely divided metals.

Chlorates with ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles, carbon.

Chromic Acid with acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine, and other flammable liquids.

Chlorine with ammonia, acetylene, butadiene, benzene and other petroleum fractions. hydrogen, sodium carbide, turpentine, and finely divided powdered metals.

Cyanides with acids.

Hydrogen Peroxide with copper, chromium, iron, most metals or their respective salts, flammable fluids and other combustible materials, aniline and nitro-methane.

Hydrogen Sulfide with nitric acid, oxidizing gases.

Hydrocarbons, general with fluorine, chlorine, bromine, chromic acid, sodium peroxide..

Iodine with acetylene, ammonia, etc.,

Mercury with acetylene, fulminic acid, hydrogen.

Nitric Acid with acetic, chromic and hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable media, fluids or gases and substances which are readily nitrated.

Oxygen with oils, grease, hydrogen, flammable liquids, solids and gases.

Oxalic Acid with silver, mercury.

Perchloric Acid with acetic anhydride, bismuth and its alloys, alcohol, paper, wood, and other organic materials.

Phosphorus Pentoxide with water.

Potassium Permanganate with glycerine, ethylene glycol, benzaldehyde, sulfuric acid.

Sodium Peroxide with any oxidizable substances, for instance: methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, furfural, etc.

Sulfuric Acid with chlorates, perchlorates, permanganates and water.

(5) Carcinogens

1. Experts agree that certain chemicals be excluded from use in secondary school laboratories. These include carcinogens or cancer causing substances identified by the Occupational Safety and Health Administration (OSHA) as having a recommended exposure levels which are essentially zero.

2. Banned known carcinogens include:

   a. 4 - Nitrobiphenyl (4-NBP)
   b. Alpha - Naphthylamine (1-NA)
   c. 4, 4'- Methylene bis (2-chloraniline) (MOCA)
   d. Methyl chloromethyl ether (CMME)
   e. 3, 3' Dichloro benzidine (and its salts)
   f. Bis chloromethyl ether (BCME)
   g. Benzidine
   h. Beta - Naphthylamine (2-NA)
   i. 4 - Aminodiphenyl
   j. Etheleneimine (EL)
   k. Beta - Propiolactone (BPL)
   l. 2 - Acetylaminofluorene
   m. 4 - Dimethylamino azobenzene (DAB)
   n. N - Nitrosodimethylamine (DMN)
   o. Vinyl chloride
   p. Asbestos

(6) Examples:

1. Examples of some experiments requiring extra precautions:

   a. A popular demonstration (though a somewhat crude analogy) is the model of a volcano using ammonium dichromate. Special precautions should be taken when doing this demonstration.

      1) Ammonium dichromate and chromic oxide (the green ash) can cause irritation of the skin and eyes. Cover the table top with newspaper for easy clean-up. Wipe all table surfaces clean after the demonstration.

2) Place small quantity (one teaspoonful or less) of ammonium dichromate in a crater formed on top of a mound of soil or in clay model of a volcano to prevent heat which is generated when the chemical is ignited from damaging the table surface.

3) Students should be at safe distance (6 to 10 feet) and not be exposed to fumes or falling ash (chromic oxide).

4) Demonstration should be done outside the classroom or a well ventilated room.

b. Oxygen may be safely prepared in elementary school science from a 3-6% solution of hydrogen peroxide by dropping a pinch of powdered manganese dioxide or few crystals of potassium permanganate into the hydrogen peroxide.

c. In the demonstration on dehydration of sugar (sucrose) using concentrated sulfuric acid, the spongy lump of carbon may contain some sulfuric acid. Pupils should not be permitted to handle the carbon or the container.

C. Storage of Chemicals

1. Store chemicals in proper containers; inspect regularly for damage and see that lids fit well.

2. Large containers of acids and alkalis must be stored at floor level or as close to the floor as possible.

3. Hazardous materials should be stored in a locked cabinet.

4. Any material in unlabeled containers should be disposed of carefully, following Department of Health procedures when they become availble.

5. Reacting chemicals should not be stored near each other. (See list of incompatibles)

6. The storage room should be well ventilated.

7. The storeroom should be orderly with all chemicals labeled; shelves should be provided with railings.

III. USE OF RADIOACTIVE MATERIALS AND RADIATION EQUIPMENT

A. Handling Radioactive Materials

1. Laboratory activities involving radioactive materials are appropriate only at the secondary school level. License-exempt radioisotopes approved by the Department of Energy (DOE) with low levels of radioactivity (microcurie quantities) are considered safe to use but must be handled with care.

2. Radioactive sources should be identified with DOE approved warning labels noting the kind of radioisotope, amount of radioactivity in microcuries, and date of preparation.

3. Avoid contamination of the hands in handling of open radioactive sources. Use tongs to handle solid specimens and rubber gloves for solutions. Wash hands with gloves on after each experiment and check with Geiger counter. After removal of gloves, the hands should be washed with soap and water and again monitored.

4. Radioactive liquids should not be pipetted by mouth. Use a pipet control device. No radioactive material should be placed in the mouth.

5. To minimize contamination of the work area in case of a spill, place a layer of newspaper over a layer of waxed paper underneath to simplify cleanup.

6. Store radioactive materials in a clearly marked locked cabinet. License-exempt quantities will be adequately shielded when stored in a plastic box or tin can and do not require thick-lead shielding.

7. Segregate and identify glassware being used with radioactive materials. Decontamination can be accomplished by washing with a detergent.

8. Keep acids away from Iodine 131 and Carbon 14 sources since a radioactive vapor may form. Avoid inhalation of fumes from reactions involving radioactive materials.

9. At the conclusion of the laboratory period, hands, feet, clothing, and working area should be checked with a Geiger counter.

10. Dispose of low activity radioisotopes in solution by diluting with large amounts of water and flushing down the drain. Solid wastes contaminated with microcurie quantities may be safely disposed in the regular trash collection.

11. A maximum of ten sources of license-free quantities of radioisotopes may be purchased and/or possessed at any one time without a license.

B. Use of Devices -- Sources of Radiation

1. Gaseous discharge tubes such as Crookes and Geissler tubes used in science classes to demonstrate physical phenomena such as deflection, fluorescence, kinetic energy, heating, and other electromagnetic characteristics may produce X-rays in the process of operation. They should not be operated at voltages higher than required for these effects in order to minimize radiation emissions.

2. To safeguard from any potential hazard due to radiation emissions, students should be at a distance of not less than six (6) feet when observing gaseous discharge tubes. For close work, an individual should not be closer than three (3) feet from the source. Inherent shielding provided by tube walls is generally sufficient for adequate attenuation of X-rays to minimize or prevent radiation hazard.

IV. ROCKETRY

A. Use of Model and "Amateur Rockets"

1. In demonstrations on rocketry, only small model rockets powered by factory-packed commercial model rocket engines and which are made of paper, plastic, wood, and other non-metallic materials may be used. Model rocket engines should be ignited by use of a remotely-operated electrical firing system. The electrical ignition element shall not be installed in a rocket engine until just before launching of a model rocket.

2. The launching device must be pointed within 30^{0} of the vertical. Model rockets shall not be flown against targets in the air or on the ground.

3. Students observing a rocket demonstration must be kept at a safe distance from the launching area.

4. Flying of model rockets must be supervised by adults and be conducted in open areas away from buildings, trees, and power lines.

5. Model rockets must not contain explosive warheads.

6. If launching of model rockets is done on school grounds, approval of an appropriate site must be obtained from the principal. If a public park on Oahu is used, an adult (after approval by the principal) must obtain a permit from the Department of Parks and Recreation, 650 South King Street, Honolulu, Hawaii 96813. Launching of model rockets is permitted from 8:00 a.m. to 4:00 p.m. daily including weekends and holidays at all county parks other than beach parks. If the park in question is jointly used by a school and the parks board, the hours for launching are 3:30 p.m. to 6:00 p.m., Monday through Friday, and 8:00 a.m. to 4:00 p.m. on weekends and holidays. For further information, call Permit Section, Department of Parks and Recreation, City and County of Honolulu, telephone 523-4525. Neighbor Islands' schools should check with their appropriate county parks department.

7. Students shall not be allowed to participate in "amateur rocketry" which involves use of home-made propellants and rocket engines and large metallic rockets. There is extreme danger of explosion and fire in the construction and operation of "amateur rockets" and in experimenting with rocket fuels.

8. Federal Aviation Regulation, Part 101, applies to firing of unmanned rockets that weigh not more than 16 oz. including the propellant, or use more than 4 oz. of propellant.

Operating Limitations:

No person may operate an unmanned rocket:

a. In a manner that creates collision hazard to aircraft.

b. In controlled airspace.

c. Within 5 miles of the boundary of any airport.

d. At any altitude where clouds or obscuring phenomena of more than 5/10 coverage prevails.

e. At any altitude where the horizontal visibility is less than 5 miles.

f. Into any cloud.

g. Within 1,500 feet of any person or property that is not associated with the operations, or

h. At night.

For additional information, write to: Federal Aviation Administration, Air Traffic Division, Airspace, Procedures, and Operations Branch, P.O. 4009, Honolulu, Hawaii 96813, or telephone: 546-8357.

Neighbor Islands' schools should contact the nearest civilian air traffic control tower for assistance or more information.

V. ELECTRICITY

A. Use of Electricity and Electrical Devices

1. There is practically no hazard involved in the use of 1.5 volt dry cells in elementary school science. Students should be cautioned not to short-circuit a dry cell since a wire across one terminal to the other can get hot enough to burn the fingers and will shorten the life of the dry cell.

2. Disconnect all wires from dry cells during storage to prevent accidental short-circuiting.

3. Remove dry cells from electrical devices in storage such as flashlights to avoid corrosion damage to equipment.

4. Storage batteries contain acid and must be carefully handled to prevent spilling of the acid. Prevent short-circuiting of a storage battery as it can cause serious burns and fire due to the high temperatures which develop in the connecting wires.

5. In secondary science activities involving electric current, voltage should be limited to a maximum of 30 volts. This does not apply in advanced courses where students have special training and appropriate precautions are taken.

6. Never grasp any electrical device which has just been used. Most electrical devices are hot after use and can cause burns on contact.

7. In removing an electrical plug, pull the plug and not the electric cord.

8. Immersion type electric heaters for heating of liquids should not be used since there is danger of accidental shock because water conducts electricity.

9. Induction coils should be clearly marked for the low-voltage and high-voltage connections to prevent possibility of electric shock from contact with the secondary coil.

10. Exposed live electric switches on front panels of laboratory and preparation room switchboards should be shielded by a protective device whenever students have access to such panels.

11. Students and teachers should be shielded from X-rays which are generated by certain electrical devices such as cathode gas discharge tubes.

12. Caution students that television sets operate at high voltage and should not be tampered with. Students should not touch metal parts of electrical appliances with one hand and contact a grounded metal surface with the other as it could create an electrical circuit with the pupil in the middle.

13. Inspect electrical cords regularly for defects in insulation or connections. Do not use equipment if cords are frayed or control switches and thermostats are not in good working order.

14. If an individual suffers a serious electrical shock, the victim should not be touched directly until the electricity is off or the circuit is broken. Artificial respiration should be given at once if the victim has stopped breathing. Follow with treatment by a physician.

15. Do not try to repair equipment yourself. This should be done by qualified personnel.

16. Ultraviolet, infrared, and optical instruments should be used with care to prevent eye injuries.

17. In case of fire on or near electrical equipment, use only carbon dioxide (CO_2) or dry powder fire extinguishers.

VI. GLASSWARE

A. Handling Glassware

1. Cutting Glass Tubing and Rods:

   a. Small-bore tubing and rods up to 20 mm in outside diameter should be placed on a flat surface and given a single transverse scratch with a sharp file or glass knife at the desired break point. Wear gloves or wrap the glass in cloth before pulling it apart by holding the tubing with the cut surface away from the body, pressing both thumbs on the side opposite from the file scratch, and pulling the hands out and back.

   b. Use the hot wire method on tubing of 20 mm or larger. Draw the wire tightly around the glass over the scratch. After the wire has been heated by a low potential current, turn the current off and direct a stream of water along the wire.

2. Fire Polishing: The ends of all glass tubings must be squared and fire polished to dull the edges.

3. Sharp edges of mirrors, prisms, and glass plates should be removed by grinding with emergy cloth or carborundum stone.

4. Inserting Glass into Stopper Holes: Holes should be made large enough to fit the glass tube. Do not force glass into stopper holes. Use glycerine to lubricate glass and rubber when assembling for easy insertion and to keep the connection from "freezing." Protect the hands with cloth before grasping the tube near the stopper and gently inserting it through the hole with a rotary motion using slight pressure. Remove glass tubing from rubber stoppers after use to prevent "freezing."

To insert glass tubing using a cork borer, moisten the stopper and place the proper size cork borer through borer, then remove the cork borer leaving the tubing in the stopper.

5. In removing glassware from old stoppers, it is safer to slit open the stopper with a razor blade than to risk breaking the glassware.

6. Heating Glassware: Use heat resistant borosilicate glassware (Pyrex) for high temperature heating or for reactions which produce heat. Place a flask or beaker on a plain gauze when heating over an open flame to avoid hot spots which may cause breaks in the bottom of containers.

   It is recommended that in the normal replacement process, only heat resistant glassware be purchased.

7. Use a glass cloth pad when heating glassware with hot plates to prevent glassware from getting broken or scratched.

8. Glassware should not be used for mixing of potentially explosive compounds.

9. Beakers should not be used as drinking glasses since they may have residues from prior use in preparing of poisonous solutions.

10. Hold glass tubing vertically when carrying. When possible, reduce long lengths of tubing to short lengths before carrying any distance.

11. Use only round bottom flasks and standard suction flasks for pressure and vacuum applications. Do not use cracked, scarred, badly scratched, or creased flasks. They implode readily.

12. Bottles of chemical reagents should not be carried by the necks to protect against accidental breakage.

13. Consider the use of alternate materials, such as polyethylene stock bottles, jars and funnels, as substitutes for glassware to reduce the danger of breakage.

14. Discarded glassware should be deposited into a conspicuously labeled "broken glass" container to avoid cuts to the custodial staff. Pick up glass splinters with dampened newspaper or paper towel and not with the fingers.

15. Caution students that glassware cools slowly and to use the proper instrument for handling heated glassware.

VII. FIELD STUDIES

A. Precautions and Practices -- Field Trips

1. Teachers must acquaint themselves with safety factors involved before planning a field trip by making an exploratory visit to the site and discussing potential hazards with responsible authorities.

2. Students should be assigned to groups small enough (Elementary - not more than 10) to insure adequate supervision by teachers or group leaders. Instruct students of safety rules and regulations of the place of field visit.

3. Students should use paper, cloth or plastic containers instead of glass jars for collecting specimens to prevent cuts and loss of specimens caused by breakage of glassware.

4. When taking a field study involving wading into water, the buddy system should be used. A prior study of the water bottom is advisable to obtain information on water depths, waves, tides, poisonous or harmful animals, and sharp and slippery rocks.

5. Conservation principles must be adequately understood and applied in field studies to avoid destruction of natural features through excessive collection of specimens or disturbing of natural habitats or organisms.

   Rocks that are overturned in tide pools to observe organisms should be returned to their original positions. Minimum numbers of specimens should be collected and, whenever possible, specimens should be returned to their habitat after study.

6. An adequately stocked first aid kit should accompany every field trip.

For further information on safety during field trips, please refer to Educational Field Trips (TAC 72-5032).

STUDENT ACCIDENT REPORT

Form No. 411, Rev. 9/76

SAMPLE

State of Hawaii
Department of Education

USE TYPEWRITER OR FIRM BALL POINT PEN WITH HARD BACKING ONLY. PLEASE DO NOT DISTRIBUTE ILLEGIBLE COPIES.

1 School _____ Code _____

2 Name _____
(last) (first) (initials)

3 Grade _____ Age _____ Sex _____ Reg _____ Spe'l _____

4 Accident Date _____
(weekday) (month) (day) (year)

5 LOCATION OF ACCIDENT

agriculture field	___	locker area	___
athletic field	___	playground	___
bathroom	___	shop	___
cafeteria, dining	___	voc-ind arts	___
cafeteria, kitchen	___	shower	___
classroom	___	stairs/steps	___
gymnasium	___	swimming pool	___
hall, indoor	___	walkway, outdoor	___
laboratory	___	washroom	___
home economics	___	OTHER (be specific)	
science	___	_____	

6 ACTIVITY INVOLVED IN ACCIDENT

athletics, inter	___	fight, individual	___
athletics, intra	___	fight, gang	___
athletics, P.E.	___	horseplay	___
athletics, recreation	___	illness	___
athletics, transportation	___	outdoor education	___
beating, assault	___	play/free time	___
bus transportation	___	running	___
class experiment	___	walking	___
excursion/trip	___	OTHER (be specific)	
fall	___	_____	

7 SPORT/GAME INVOLVED IN ACCIDENT

baseball	___	sham battle	___
basketball	___	soccer	___
dodgeball	___	softball	___
football, flag	___	speedway	___
football, regular	___	t-ball	___
football, touch	___	track & field	___
gymnastics	___	trampoline	___
kickball	___	wrestling	___
martial arts	___	OTHER (be specific)	
rifle team drill	___	_____	

8 APPARENT NATURE OF INJURY

abrasion	___	poisoning	___
bite	___	what?	_____
bruise	___	puncture	___
bump	___	scalding	___
burn	___	shock, electric	___
concussion	___	shock, physical	___
cut/laceration	___	splinter	___
dislocation	___	sprain	___
fracture	___	sting	___
gunshot wound	___	OTHER (be specific)	
internal	___	_____	

9 IMMEDIATE ACTION TAKEN

first aid ___ by _____
to health aide/room ___ by _____
to home ___ by _____
to doctor ___ by _____
Dr _____
to hospital ___ by _____
hospital's name _____
notified parent ___ guardian ___ friend* ___
by whom _____
how _____
when _____
*name of friend _____
insurance yes ___ no ___ unknown ___
plan/firm _____

10 DEGREE OF INJURY/DISABILITY

disabling, no	___	permanent	___
disabling, temporary	___	death	___
Number of School Days Lost (if over 1/2 day, record after return)			___
Number of Home Days Lost (optional and only if over 1/2 day)			___

11 PART OF BODY INJURED

Head and Neck Area ___ specifically _____
Trunk/Torso ___ specifically _____
internal ___
Upper Appendage ___ specifically _____
Lower Appendage ___ specifically _____

12 EQUIPMENT, FIXTURE, FURNISHINGS, HAZARD INVOLVED IN ACCIDENT (be specific)

13 PROPERTY DAMAGE

school	___	student	___
staff	___	other	___
Estimated Value $	_____		

14 SUPERVISION AND WITNESSES

staff, assigned	___	witness(es), yes	___
staff, not assigned	___	witness(es), no	___
staff, absent	___	name(s)	_____
staff, did not see	___		

15 PERIOD OF THE DAY

before school	___	afternoon hours	___
morning hours	___	afternoon recess	___
morning recess	___	after school	___
lunch/free time	___	non-school hours	___

16 NARRATIVE (What happened? How? Why? Hazard? Unsafe action? etc.)

17 PREVENTIVE MEASURES (your recommendations for preventing accidents of this kind)

18 REPORTED BY (signature, please)

name _____
position _____ date _____

19 PRINCIPAL (signature, please)

_____
date _____

F-E23

Distribution: WHITE - School, CANARY - District Office, PINK & GOLDENROD - Student Safety, OIS

TAC 76-2175

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RESOURCE MATERIALS

RESOURCE AND REFERENCE MATERIALS

The materials in this section are, for the most part, information sources regarding specific science content topics. This list obviously cannot be exhaustive. It is intended as a representative list of materials that classrooms would have in fewer numbers than either curriculum project or textbook materials.

Goldstein: A Compilation of Materials for Environmental Education. National Education Association and National Park Service, 1972 (TAC 72-5421)

The area of environmental education is not well defined and perhaps it never will be. In order to assist teachers in search of materials to institute local environmental education programs, this document and Environmental Education Programs and Materials, below, have been provided for each school library. These documents contain descriptions of diverse materials and programs related to the environment and to "environmentalizing" education.

Helgeson: Environmental Education Programs and Materials. National Center for Education Communication (Superintendent of Documents, PREP Report #33.

Mine Publications: Examining Your Environment Series. Winston Press, 1972

Titles:

Mapping Small Places	Birds
Snow and Ice	Mini-Climates
Pollution	Running Water
Trees	Astronomy

National Wildlife Federation: Environmental Discovery Units.

Each unit is activity-oriented. Students become involved with some aspect of their environment and study it in depth.

Titles	Grades
Tile Patterns and Graphs	1-2
Nature's Part in Art	3-6
Genetic Variation	4-9
Soil	2-9
Plant Puzzles	1-6
Brine Shrimp and Their Habitat	1-5
Change In a Small Ecosystem	5-9
Plants in the Classroom	3-6
Vacant Lot Studies	5-9

Environmental Discovery Units (contd.)

Titles	Grades
Differences in Living Things	4-8
Shadows	1-8
Wind	3-6
Snow and Ice	1-6
Man's Habitat, The City	4-9
Fish and Water Temperature	4-9
Oaks, Acorns, Climate, and Squirrels	1-6
Sampling Button Populations	3-9
Nature Hunt	K-1
The Rise and Fall of a Yeast Community	6-9

NSTA: Investigating Science With Children Series. Macmillan, 1964

Each book is concerned with one area of science. Activities and learnings are categorized according to complexity. Contains background information, laboratory investigations and summaries of key ideas.

Titles

Living Things
The Earth
Atoms and Molecules
Energy in Waves
Motion
Space

Set of 6 volumes

Time-Life: Life Nature Library. Silver Burdett

Time-Life: Life Science Library. Silver Burdett

Wurman: Yellow Pages of Learning Resources. MIT Press

This volume is just what the title implies. It offers to students and teachers invitations to explore their communities and use their environments as learning content.

Watts: First Books Series - Science. Watts, Franklin, Inc.
(Each title classified by reading levels)

Astronomy	(4-10)	Bugs	(3-6)
Air	(4-10)	Conservation	(4-7)
Antarctic	(4-7)	Caves	
Bees	(3-6)	Color	(5-10)
Birds	(3-6)	Deserts	(4-10)
Earth	(4-10)	Prehistoric Animals	(4-7)
Electricity	(4-8)	Sea Shells	(3-6)
Energy	(6-10)	The Seashore	(4-6)
Food	(3-5)	Snakes	(4-10)
Gardening	(4-6)	Sound	(4-10)
Glaciers	(4-10)	Space Travel	(4-7)
Glass	(3-5)	Stones	(4-10)
The Human Senses	(4-10)	Time	(6-10)
Light	(6-10)	Trees	(3-10)
The Jungle	(5-10)	Tropical Mammals	(4-7)
Machines	(4-6)	Volcanoes and Earthquakes	(4-10)
Mammals	(4-10)	Water	(3-5)
Microbes	(4-10)	Weather	(4-7)
Measurement	(4-6)	Weeds	(4-10)
Mountains	(7-10)	Wild Flowers	(4-6)
The Ocean	(4-10)	Wildlife Sanctuaries	(4-10)
Plants	(4-10)		

Wonder Series: How and Why Wonder Books. Grosset & Dunlap, 1960.

Each book covers a single topic in science. Reading levels from grades 4-9.

Ants and Bees	Magnets and Magnetism
Atomic Energy	The Moon
Birds	The Microscope
Butterflies and Moths	Our Earth
Beginning Science	Prehistoric Mammals
Chemistry	Planets and Interplanetary Travel
Caves to Skyscrapers	Rocks and Minerals
Dinosaurs	Rockets and Missiles
Electricity	Reptiles and Amphibians
Explorations and Discoveries	Sea Shells
Flight	Stars
Fish	Science Experiments
Horses	Sound
Insects	Time
Light and Color	Weather
Machines	Wild Animals

PERIODICALS

For the Student:

Ranger Rick's Nature Magazine. Membership publication of the National Wildlife Federation, 381 West Center Street, Mation, Ohio 43302. Monthly except June and September.

Articles on wildlife and conservation.

For the Teacher:

Science and Children. National Science Teachers Association, 1201 Sixteenth Street, N.W., Washington, D.C. 20036

Elementary membership in NSTA, which includes the subscription,

The journal is devoted exclusively to elementary schoo` science teaching. It includes classroom tips, reviews of materials and new developments.

Learning. 530 Universty Avenue, Palo Alto, California 94301

This is a practical magazine for innovative teachers.

PROFESSIONAL BOOKS

Albert: Correlation of Activity-Centered Science and Mathematics. Activities Resource Center, 1972

Blough: Elementary School Science and How to Teach It. Holt, 1974

Carin: Teaching Science Through Discovery. Merrill, 1975

EDC: A Working Guide to the Elementary Science Study (ESS). Webster Division/McGraw-Hill, 1971

EDC: The ESS Reader. Educational Development Corp., 55 Chapel Street, Newton, Massachusetts 02160

Gosline: Handbook of Hawaiian Fishes. University of Hawaii, 1965

Karplus: A New Look At Elementary Science: SCIS. Rand McNally

Keeping: Joseph's Yard. Watts, 1969

MacDonald: Anatomy of An Island. Bishop Museum, 1967

NSTA: Helping Children Learn Earth-Space Science. National Science Teachers Association, 1201 Sixteenth St., N.W., Washington, D.C. 20036

NSTA: How To Do It Series. National Science Teachers Association

Titles

How to Use Behavioral Objectives in Science Instruction
How to Plan and Organize Team Teaching in Elementary Science
How to Teach Measurements in Elementary School Science
How to Evaluate Science Learning in the Elementary School
How to Use Photography as a Science Teaching Aid
How to Utilize the Services of a Science Consultant
How to Care for Living Things in the Classroom
How to Teach Science Through Field Studies
How to Record and Use Data in Elementary School Science
How to Individualize Science Instruction in the Elementary School
How to Study the Earth from Space
How to Tell What's Underground
How to Investigate the Environment in the City: Air and Water
How to Read the Natural Landscape in Forests and Fields

NSTA: Individualized Science--Like It Is. National Science Teachers Association, 1972

Piltz: Creative Teaching of Science in the Elementary School. Allyn, 1974

Raths: Values and Teaching: Working with Values in the Classroom. Merrill, 1966

Romey: Risk-Trust-Love: Learning in a Humane Environment. Merrill, 1972

Schmidt: Teaching Science with Everyday Things. McGraw, 1968

Sellberg: Discovering Science in the Elementary School. Addison-Wesley, 1970

Stearns: Geology of the State of Hawaii. Pacific Books, 1966

Stone: Experiences for Teaching Children Science. Wadsworth, 1971

TAC: Guide to Science Laboratory Safety and Practices - K-12. (TAC 74-8251, September, 1974)

Xerox: Commentary for Teachers. Ginn.
Teacher self-instruction papers for SAPA teachers.

SUPPORTIVE PROGRAMS, SERVICES, AND ACTIVITIES
FOR GRADES K-6

ETV Science Programs

Educational television provides opportunities for sharing outstanding teachers and other resources and and assists teachers in their preparation and presentation of science lessons. It extends the boundaries of the classroom, enriching both the teacher's and learner's instructional environment.

In-School Programs

(Refer to the Educational Television In-School and In-Service Broadcast Schedule which is printed yearly)

Specials:
"National Geographic Specials"
"Wild Kingdom"
"Born Free"
"Animals, Animals"

Audiovisual Resources: 16 mm Films

Educational motion pictures can be used in the classrooms to convey information and promote the development of concepts and ideas. There are over 5300 films to support school instructional programs.

(Refer to 16 mm Film Catalog, 1973 with updated information TAC 73-6119, 1973)

Film strips/slides
Film Loops
Projectuals
Tapes

Many schools have excellent collections of film strips, loops, and projectuals. School librarians can assist in locating these resources.

Field Trips

Field trips offer valuable experiences which help children learn through first-hand observation and study of community resources. Nearby streams, mountain valleys, ocean tide pools, or the university farm are examples of field trip sites with a wealth of information that can arouse curiosity in students, enhance learning, and add meaning to classroom instruction.

(Refer to A Compendium: Campsites and One-Day Visitation Sites, TAC 77-3690)

Community Resources . University-Community College Personnel . Federal-State Agency Personnel . Parents	There are many community resource people with expertise in specific areas such as horticulture and weather prediction.
High School Science and Agriculture Teachers	Secondary science teachers are excellent resource people because of their subject area background. They can assist in securing supplies and materials that are difficult to find in the elementary school.

GLOSSARY

ATTITUDE: A feeling or emotion towary a fact or state.

CARDINAL DIRECTIONS: The main or basic directions such as North, South, East, West.

CONTROL: The act of cancelling or neutralizing the effects of extraneous variables which requires keeping all the part of an experiment which resembles another being studied, with all factors identical, except the variable conditions between the experimental and control (groups constant except the independent or treatment variable).

COORDINATE: Any number of magnitude that determines position of points (as on a graph) or plane.

DECISION-MAKING: The act of deciding which course to choose from the available alternatives.

DEPENDENT VARIABLE: That factor which is observed and measured to determine the effect of the independent variable.

EXTRAPOLATION: To project by inference into an unexplored situation such as predictions on a graph or data table.

GENERALIZATION: A statement, idea or principle which asserts something to be true either of all members of a certain class or of a particular part of that class--a statement of relationships among conceptualized patterns of behavior.

HISTOGRAM: A pictorial representation showing the range and frequencies of data.

HYPOTHESIS: A tentative supposition adopted to explain certain facts and to guide the investigation of others.

INDEPENDENT VARIABLE: That factor which is measured, manipulated, or selected by the experimenter to determine its relationship to an observed phenomenon.

INFERENCE: The act of obtaining a judgment of logical conclusion from given data (or premise)

INTERPOLATE: Predict readings between observed data.

INQUIRY: A strategy employed by teachers and students in solving problems by going through a structured thought process. An approach to the process of knowing (learning) which involves the learner's knowledge and use of multiple thinking processes in seeking solutions to problems.

MATRIX: A rectangular array of numbers or objects, etc., such as:

FRUITS	RED	YELLOW
Round	*apple*	*grapefruit*
Long		*banana*

MODEL: A representation of reality; may be displays: graphics, objects or dynamic representation of ideas. Theoretical models are set of ideas which explain observations and justify predictions that go beyond available data.

PHENOMENA: Any observable fact or event.

PROCESS: The random or ordered operations which can be associated with acquiring knowledge, utilizing or communicating knowledge, arriving at decisions, or exercising intuition.

PROGRAM GOALS: Broad goals that serve as guides to planning and organizing programs (for science education). They serve the purpose of clarifying the purpose of education.

RATIONAL HUMAN BEING: A logical individual capable of making decisions using knowledge and skills necessary. Individuals are in complete command of themselves.

SCIENTIFIC LITERACY: Individuals who possess the necessary skills and knowledge to be a participating and contributing member of society (see Overview for a complete definition).

SET: Any collection of objects that may or may not have common properties other than that of belonging to the set.

SUBSET: Set X is a subset of A if all members of X are members of A. Example: All fruits are members of Set A, but only yellow fruits are members of subset X.

SUB-SYSTEM: A system that is entirely included in another system.

SYSTEM: A group of related objects that form a whole. Systems often are selected because the objects interact or have the ability to do so.

TEACHING STRATEGY: The carefully considered and evaluated plan of action the teacher uses to reach a set of objectives.

VARIABLE: A condition that can differ from one experiment to another.

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Office of Instructional Services. Hawaii Career Development Continuum, Curriculum Guide 4-6. Department of Education, State of Hawaii, Honolulu, Hawaii, June, 1974.

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TEACHER INPUT FORMS

SCIENCE EDUCATION
OFFICE OF INSTRUCTIONAL SERVICES, DOE
1270 Queen Emma Street, Room 1102
Honolulu, Hawaii 96813

TEACHER INPUT FORM
(SCIENCE CURRICULUM GUIDE, GRADES K-6)

1. Name (optional)_____

   School (optional)_____

   Date_____

2. The Science Curriculum Guide, Grades K-6, can be improved by Adding To _____, Deleting From_____, or Modifying_____

   (Please Check) the following section(s):

   a. Title of Section_____. Page(s)_____

   b. Title of Section_____. Page(s)_____

   c. Title of Section_____. Page(s)_____

   d. Title of Section_____. Page(s)_____

3. My recommendations are to do the following:

4. I am also submitting materials which I have found useful in my classroom and may be of interest to others if included as possible additions to the Guide.

   Yes_____ No_____ (Please Check)

   The materials are attached to this Form or can be obtained by calling

   _____.
   Telephone Number

PLEASE FOLD AND STAPLE TO DISPLAY ADDRESS ON OPPOSITE SIDE AND MAIL.